On a tight leash: Does bank organizational structure matter for macroprudential spillovers?

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Abstract

This paper examines whether the organizational form of multinational banks' foreign affiliates affects cross-border spillovers of macroprudential regulation. We compare changes in the growth of lending provided by foreign banks' branches versus subsidiaries in the United Kingdom in response to changes in capital requirements, lending standards and reserve requirements in foreign banks' home countries. Our results suggest that a tightening of capital requirements at home reduces UK branches' interbank lending growth by 5.7pp more relative to subsidiaries. We link this effect to the higher degree of control which parent banks hold over operations of their foreign branches compared to subsidiaries. Supporting this hypothesis, a set of further tests illustrates that the response of foreign affiliates operating under a branch structure is stronger where parent banks are more likely to delegate more decision making authority to the board of directors of their subsidiaries.

Key words: Macroprudential regulation, cross-border lending, credit supply, foreign banks' organizational structure

***JEL* classification:** G21, G28, E51, E58

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1. Introduction

Multinational banks operate in foreign markets primarily under two organizational structures, a subsidiary and/or a branch. When deciding on the structural form of foreign operations, banks must consider a number of factors, including regulatory and taxation arrangements in the host countries (Fiechter, Otker-Robe, Ilyna, Hsu, Santos, and Surti, 2011) as well as factors related to the business model of the group (Hoggarth, Hooley, and Korniyenko, 2013).[1] Dell'Arrica and Marquez (2010) also consider various host country risks as important determinants in this decision making process. Their theoretical model suggests that a subsidiary structure benefits the banking group by protecting it from economic risks due to limited parent-affiliate liability (such risks may result from changes in the macroeconomic conditions, which in turn may affect the creditworthiness of borrowers and thus lead to higher default rates). A branch structure on the other hand is more beneficial in countries where expropriation risk is higher (examples of expropriation risks include, forcing banks to hold government debt or lending to favoured entities).[2]

In this paper we examine if the choice of organizational structure plays a role in the cross-border transmission of regulatory changes. We ask if multinational banks' branches reduce their lending in foreign markets (i.e., the host country) more than subsidiaries in response to changes in the regulatory environment in their domestic markets (i.e., the home country). We further investigate whether this effect can be explained by a varying degree of control which parent banks hold over their affiliates operating under different organizational forms. To answer these questions, we exploit a novel dataset on 87 changes in the intensity of macroprudential regulation in 15 countries over the period 1997 to 2014. Our analysis focuses on the effect of tightening capital requirements, lending standards and reserve requirements on foreign banks' lending to bank and non-bank borrowers in the UK.

Violations of the Modigliani-Miller theorem for banks, such as the existence of deposit insurance, predict that banks choose inefficiently high levels of risk and lending which can be reduced by capital regulation (Kim and Santomero, 1998; Thakor, 1996). The empirical literature documents reductions in banks' domestic and cross-border lending propelled by increases in capital requirements (Peek and Rosengren, 1997 and 2000; Aiyar, Calomiris, Hooley, Korniyenko, and Wieladek, 2014; Aiyar, Calomiris and Wieladek, 2014a). Our contribution to this literature is that we explore to what extent changes in lending provided by foreign banks in host countries in response to regulatory changes in their home countries depend on whether the lending is done via a branch or a subsidiary.

Why would the change in lending following a tightening of macroprudential regulation in their home countries differ depending on the organizational form of foreign banks? We argue that the legal distinction between branches

[1] Branches of foreign banks are subject to home country regulation, whereas subsidiaries are mainly regulated by the host country authorities. Therefore, where the regulation in a host country is unfavourable compared to home country regulation, multinational banks may find it more beneficial to operate under a branch structure. In terms of business model considerations, banks focusing mainly on wholesale operations may prefer to operate in the host country under a branch structure, whilst a subsidiary structure may benefit those banking groups which aim to serve non-bank customers and establish banking relationships in the host market. This reflects the fact that the branch structure allows for cheaper and more flexible transfer of funds between the parent and its foreign entity.

[2] Cerutti, Dell'Ariccia and Martinez Peria (2007) provide empirical evidence supporting these findings.

and subsidiaries plays a key role. Under the branch structure foreign affiliates constitute an inseparable part of the parent organization. On the contrary, subsidiaries are considered as stand-alone institutions, with their own board of directors which needs to verify and approve business decisions, making it more difficult for the parent to control a subsidiary relative to a branch (Hoggarth, Hooley, and Korniyenko, 2013; Fiechter, Otker-Robe, Ilyna, Hsu, Santos, and Surti, 2011). Therefore, the organizational form of a foreign affiliate determines the degree of control which the parent organization holds over its foreign affiliate. Given that branches form an integral part of the parent bank, one could expect that in the case of a capital requirement tightening, the parent bank might find it easier and swifter to reduce lending provided by its foreign branches (relative to its subsidiaries) in order to meet a given capital ratio. This is the main focus of our paper.

However, it could be assumed that since subsidiaries, unlike branches of foreign banks, are primarily subject to the regulation and supervisions of their host country, they should not be affected by a tightening of macroprudential regulation by their home country's regulators. In such instances, the differential effects we are likely to find in this paper would be a purely mechanical one. The Bank Regulation and Supervision Survey carried out by the World Bank and presented in Appendix A, shows that most countries which tighten capital requirements in our sample calculate the adequate level of capital using consolidated balance sheet information, which includes assets and capital of all of the groups' foreign affiliates, including subsidiaries.[3] Therefore, in response to a tightening of capital requirements, a banking group may decide to reduce lending by their branches, subsidiaries, or both to comply with the new macroprudential regulation.[4]

Providing compelling evidence that the magnitude of cross-border regulatory spillovers varies with the organizational structure of foreign banks affiliates requires that we address several challenges. Firstly, decisions regarding lending retrenchment depend to a large extent on the decisions made at the parent-bank level. These decisions can reflect the strength of parents' lending relationships both at home and abroad (Peek and Rosengren, 1997, 2000) or the "level" of the home bias (Giannetti and Laeven, 2012). Geographical distance between banks' home and host countries might also affect banking groups' strategies with respect to cross-border lending (Aiyar, Calomiris, Hooley, Korniyenko, and Wieladek, 2014; De Haas and Van Horen, 2013). Secondly, changes in the intensity of macroprudential regulation can disproportionately affect banking groups due to their balance sheet characteristics. For instance, banks or banking groups with low capital buffers prior to a tightening of capital regulations might respond differently to those holding a higher capital buffer (Popov and Udell, 2012; Gambacorta and Mistrulli, 2004). Similarly, banks holding lower excess reserves are likely to reduce their lending to a greater extent to absorb an increase in required reserves relative to banks holding higher excess reserves (Mora, 2014).

[3] Appendix A presents a survey conducted by the World Bank which confirms that in most countries multinational banks calculate their capital ratios on a consolidated basis. In our sample the exceptions are China, South Africa and Switzerland. However, the results presented in Table 10 suggest that excluding Chinese, South African and Swiss banks from our sample does not affect our inferences.

[4] It could also be argued that branches of foreign banks will reduce their lending more than subsidiaries as a result of capital shifting. A branch structure allows for cheaper and more flexible transfer of funds between the parent and its foreign entity. Given this, it could be argued that parent banks will move capital from their foreign branches in response to tighter capital requirements. However, technically branches don't hold their own capital as they are not a separate legal entity. And since calculation of required capital is performed at the consolidated level, this strategy does not help parent banks to increase their capital ratios and therefore it is unlikely to be implemented by parent banks.

Kashyap and Stein (2000) show the effect of monetary policy on banks' lending is significantly influenced by banks' balance sheet liquidity. Thirdly, country-time-varying factors might also influence banking groups' lending strategies in foreign markets. For example, increasing (decreasing) demand for parent banks' products in the home market might provide an impulse to lend less (more) in foreign markets.

In light of these issues, accurately establishing the degree to which organizational form affects the cross-border transmission of changes in the intensity of regulation requires that one controls for all factors which might affect parent banks' lending decisions. But this is made difficult by the fact that many of these aspects, such as the strength of home bias, are difficult to observe and quantify. We overcome this problem by using an identification strategy that focuses on UK lending provided by branches and subsidiaries which belong to the *same* banking group. In other words, we limit our sample to foreign affiliates of multinational banks which operate at least one branch and one subsidiary in the UK. This allows us to exploit heterogeneities in the response to macroprudential regulation implemented in the home county using difference-in-difference estimations, while including banking group-time fixed effects.

The UK is an ideal country to examine whether spillovers depend on organizational form because there were 321 branches and 176 subsidiaries of multinational banks operating in the country between 1997 and 2014. In addition, 38 banking groups simultaneously operate under both organizational structures. Multinational banks opt to operate in host countries under both organizational structures to exploit benefits specific to both organizational forms. In the UK, branches and subsidiaries of multinational banks may co-exist within the same institution due to legal requirements. For example, banks headquartered in countries outside the European Economic Area (EEA) often establish subsidiaries in the EEA to allow them to provide investment banking and lending services throughout the EEA without having to be separately authorised in each individual state. Banks may also decide to operate branches and subsidiaries in host countries simultaneously as a result of a merger. Becoming authorised as a branch or subsidiary is a lengthy and expensive process and so parent banks may wish to maintain existing legal structures, even if not currently optimal for their business. Additionally, London is a major financial centre, due to historical reasons, agglomeration effects, its time zone, language and legal system. This makes it a convenient centre to serve a wide range of types of clients and to provide different products including lending and investment banking services.

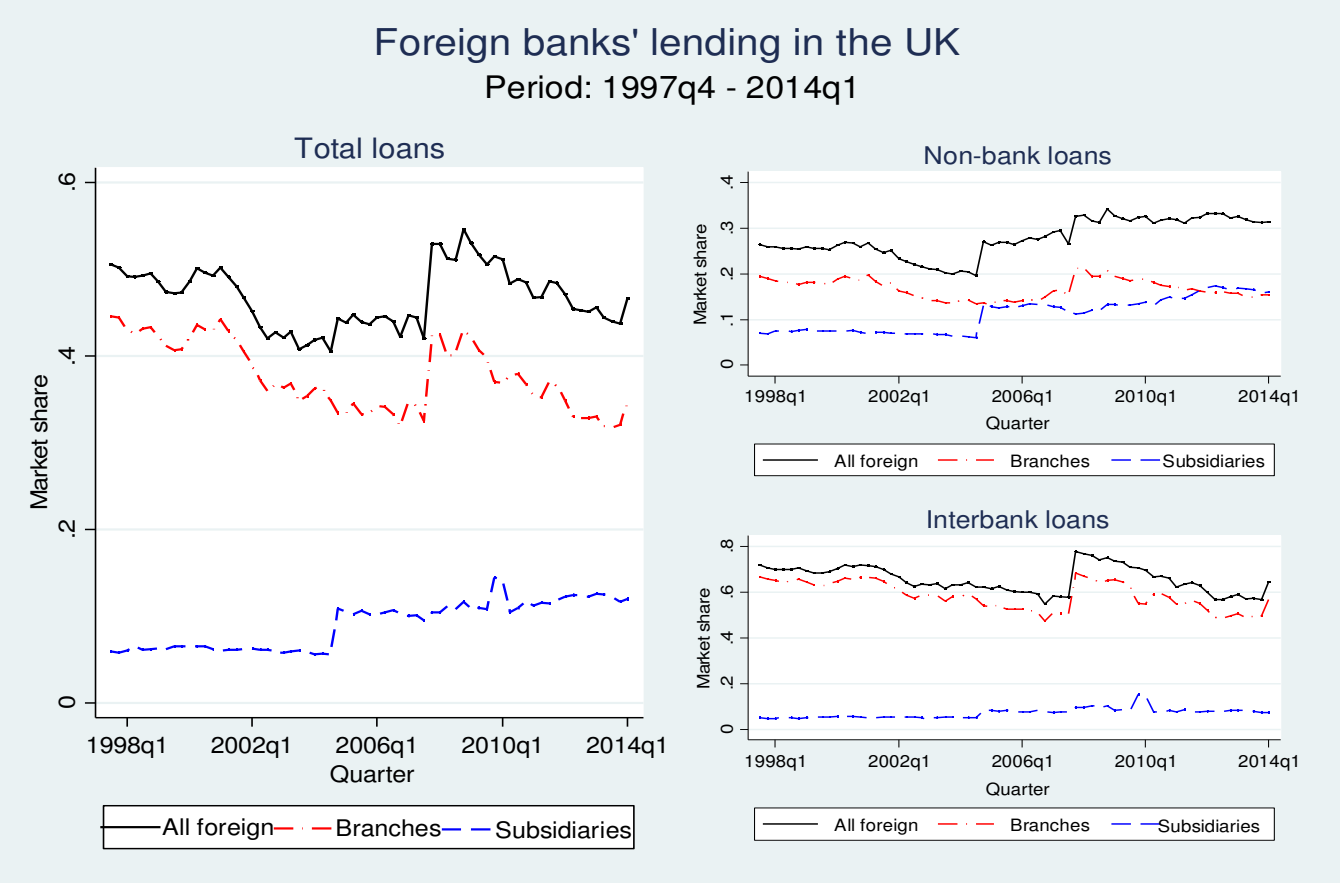
Together, branches and subsidiaries account for a high share of lending in the UK. As illustrated in Figure 1, during the period 1997-2014 both branches and subsidiaries provided approximately 50% of loans to UK borrowers. Figure 1 also shows differences in the business models of both bank structures. Branches provide significantly more lending to other financial institutions operating in the UK, whilst subsidiaries mainly focus on lending provided to non-bank borrowers. Importantly however, both branches and subsidiaries are active in both markets.

Our results suggest that a tightening capital requirements leads to an 8.2 percentage point decrease in interbank lending provided by foreign banks in the UK irrespective of their organizational form. We also show that such regulatory tightening disproportionately affects different organizational types of foreign banks. We find that an

increase in capital requirements at home causes foreign branches to reduce their lending growth to other banks operating in the UK by 5.7 percentage point more than foreign subsidiaries. We also document that tighter lending standards in domestic markets lead to a significant increase in foreign banks' lending to non-bank borrowers (5.9 percentage points). However, we do not find differential effects for a tightening of this type of macroprudential regulation. We also find that a tightening of capital requirements does not affect foreign banks' lending to non-bank borrowers in the UK and that tightening of lending standards does not affect foreign banks' lending to other banks operating in the UK. Finally, we do not find statistical significance for the results investigating changes in non-bank and interbank lending following a tightening of reserve requirements.

In an additional set of tests we document that the differential effect of a change in macroprudential regulation is only contemporaneous. We find that in the first, second, and third quarter following a tightening of regulation both branches and subsidiaries do not exhibit statistically significant differences in their lending behaviour. We strengthen our identification by estimating a number of falsification tests, regressions removing subsidiaries subject to individual capital requirements increases, tests excluding individual countries, control variables and providing results of regressions with alternative ways of clustering standard errors.

Figure 1
Foreign banks' lending in the UK



Notes. Figure 1 presents evolution in the market share of total lending, lending to the UK non-bank private sector and interbank lending provided by branches and subsidiaries of foreign banks in the UK.

We perform a set of tests which help us identify the transmission mechanism behind our baseline results. Specifically, we focus on the degree of control which a parent bank is likely to grant its subsidiary. We follow the literature on delegation of decision making authority within firms, which suggests that parent banks will grant more credit decision making rights to subsidiaries if foreign affiliates provide significantly more non-bank lending (Aghion and Tirole, 1997; Williamson, 1967), if parent banks are operating more affiliates in the UK (McAfee and McMillan, 1995; Alonso, Dessein, and Matouschek, 2008) and finally if the distance separating the banking group headquarter and foreign affiliates is higher (Dessein, 2002; Agarwal and Hauswald, 2009). In addition to tests based on delegation of authority, we conduct a test exploiting information about the composition of subsidiaries' boards of directors. Particularly, we look at the share of independent directors. In the UK, the Prudential Regulatory Authority advises banks (including subsidiaries of foreign banks) to include an equal number of independent and executive directors on their boards. The former group of directors should provide independent oversight of the executives and their decisions (PRA, 2016). The Bank for International Settlements also recognises the importance of independent directors on boards of internationally operating banks. According to the Bank for International Settlements (BIS) independent directors are supposed to allow for impartial evaluation of any group level decisions affecting operations of a subsidiary (BIS, 2010). Therefore, a higher share of independent directors should allow for greater autonomy of subsidiaries.

Tests aiming at documenting proposed transmission mechanisms rest on the assumption that by delegating authority to its subsidiaries, parent banks surrender a certain level of control over these institutions' operations. In those groups where a parent institution's control over its subsidiaries is lower, foreign branches should respond more strongly to tighter macroprudential regulation. As a result, we should observe stronger differential effects for those banking groups.

To perform these tests, we split banking groups into subsamples according to the share of non-bank lending, the number of affiliates, the distance between the headquarter of the banking group and foreign affiliates and the share of independent directors on subsidiaries' boards of directors. We re-run our baseline regressions using these subsamples and - in line with the above theoretical predictions - we find that differences in the magnitude of the effect between subsamples in response to tighter capital requirements are stronger for groups where subsidiaries are likely to be more independent.

These results yield support for the notion that the differential effect is at least in part driven by the degree of control parent banks hold over their affiliates. However, we acknowledge that other factors may potentially drive differential responses. These are likely to be related to the factors driving the choice of organizational form. Branches engage significantly more in interbank lending relative to subsidiaries, which could explain why we observe a stronger effect of capital requirements on this type of lending provided by branches. Alternatively, additional regulation affecting only subsidiaries and not branches, such as bank specific capital requirements imposed on UK subsidiaries of multinational banks by the Prudential Regulatory Authority may play a role. To that extent we test if these alternative explanations affect our results in robustness tests section of the paper. After

controlling for the level of interbank lending and removing institutions affected by bank-specific regulation, the differential effect of capital requirements on interbank lending still exists.

Our work is motivated by, and contributes to, three strands of literature. The first are studies that document how multinational banks transmit financial shocks across country borders. Cetorelli and Goldberg (2011) find that banks from advanced economies restricted their credit supply in developing markets during the recent financial crisis. Schnabl (2012) and Chava and Purnanandam (2011) show that international banks' liquidity shocks triggered by the 1998 Russian default crisis were transmitted via interbank lending to Peru and the US, respectively. Aiyar (2012) documents how foreign banks contributed to the lending contraction in the UK during the crisis by withdrawing funding from UK-resident affiliates. Giannetti and Laeven (2012) show that crisis periods increase home bias among multinational banks, reflected in shifts from foreign to domestic lending.

A second strand of literature examines heterogeneities in the spillovers of bank balance sheet shocks. De Haas and Van Horen (2013) use the collapse of Lehman Brothers as an exogenous shock affecting the liquidity of internationally operating banks and find that foreign-owned banks significantly contract their lending in host markets. However, the key finding for this paper is the substantial heterogeneity in the extent to which different banks retrenched from the same country. Banks reduced credit supply mainly in countries geographically distant from their home country, where foreign banks were less experienced, where they operated under a branch structure and where they were disintegrated from the network of domestic co-lenders. Popov and Udell (2012) study whether contractions in lending provided by foreign banks may be sensitive to parent banks' balance sheet conditions. They find that firms in emerging market countries experienced more difficulty obtaining credit from foreign banks whose parent banks suffered from negative shocks to their financial conditions. Firms in their sample were particularly constrained in localities served by banks with lower Tier 1 capital ratios. In addition to these studies Hoggarth, Hooley and Korniyenko (2013) show that lending provided by foreign branches in the UK was more volatile during the recent financial crisis compared to lending provided by foreign banks' subsidiaries.[5]

Finally, there is the literature on cross-border spillovers of regulatory changes via multinational banks' operations. Peek and Rosengren (1997, 2000) evaluate the effect of the Japanese stock market collapse which coincided with the introduction of the Basel Accord in Japan in the early 1990s. They find that multinational Japanese banks whose capital ratios fell below the required level due to rapid declines of the stock market reduced their commercial and industrial, and real estate lending in the US, to comply with the new and tighter capital regulation. Aiyar, Calomiris, Hooley, Korniyenko and Wieladek (2014) examine the effect of bank specific capital requirements on banks' cross-border lending. They find that an increase in UK (home) capital requirements by 100 basis points is associated with a reduction in the growth rate of cross-border credit by 5.5 percentage points. Using the same dataset on bank specific capital requirements, Aiyar, Calomiris and Wieladek (2014a) also find that an increase in capital requirements leads banks to cut lending in their domestic market, which is partly offset as

[5] Goulding and Nolle (2012) also show that foreign branches lending was much more volatile compared to lending provided by subsidiaries in the US, whereas Albetrazzi and Bottero (2014) find that foreign owned branches operating in Italy shrunk their lending in response to the collapse of the Lehman Brothers much more than subsidiaries of multinational banks.

foreign banks expand their lending to this market. Aiyar, Calomiris and Wieladek (2014b) show that part of this offset in lending in response to an increase in capital requirements on the UK subsidiary is because a foreign banking group shifts loans from its UK-regulated subsidiary to its affiliated branch in the UK, likely as a form of regulatory arbitrage. Cross-border spillovers of financial regulation have also been found to affect banks' lending standards. Ongena, Popov and Udell (2013) find that banks respond to tighter lending standards in the home country by taking more risk in foreign markets, reflected in more lending to ex-ante risky firms.

The remainder of the paper proceeds as follows. The next section explains our data and the conceptual framework. In Section 3 we discuss our identification strategy. We present our results in Section 4 and we conclude in Section 5.

2. Hypotheses and Data

2.1 Capital requirements hypothesis

Aiyar, Calomiris, Hooley, Korniyenko and Wieladek (2014) test hypotheses surrounding the relationship between the intensity of capital requirements and banks' cross-border lending. Banks which are required to increase their capital ratios can do so either by increasing their capital (capital issue, retained earnings), reducing their capital buffer or by reducing their risk-weighted assets. Since raising capital is expensive, and the empirical evidence suggests that banks prefer to keep a constant capital buffer, banks may prefer to reduce risk weighted assets. Multinational banks, which calculate their capital ratio based on consolidated accounts, including assets of their cross-border branches and subsidiaries, have a choice of either reducing lending in the home market or in foreign markets. Since banks are likely to prioritize their operations in their home markets, they are likely to prefer to contract lending provided by their foreign affiliates in their host markets.[6]

Our study extends this hypothesis by studying whether multinational banks' response to macroprudential regulation varies with the organizational form of their foreign affiliates. In other words, we want to find out if branches belonging to multinational banks restrict their lending to a greater extent than multinational banks' subsidiaries. The main factor which makes us believe that such heterogeneity exists is the degree of control which parent banks hold over their foreign affiliates. A foreign entity operating under the branch structure constitutes an integral part of the parent bank. Its assets and liabilities constitute a fraction of the parent organization. Subsidiaries, on the other hand, under most circumstances are treated as separate institutions. They have their own board of directors who make decisions regarding the functioning of the subsidiary.[7] Given this difference, we hypothesise the cross-border effect of capital requirements to be more pronounced for branches than for subsidiaries.[8]

[6] Giannetti and Laeven (2010) and Presbitero, Udell and Zazzaro (2014) provide empirical evidence on the existence of this home bias effect.
[7] Even if the board of directors is appointed by the parent bank, decisions such as whether to reduce lending have to be approved by the subsidiaries' board, which makes this process more time consuming than in the case of branches.
[8] Multinational banks calculate their capital ratios based on consolidated accounts, which include assets of their cross-border branches and subsidiaries. Therefore, although subsidiaries are subject to host country regulation, they will also be subject to macroprudential regulation in their home markets.

2.2 Lending standards hypothesis

To construct the hypotheses related to lending standards regulation, we follow the reasoning in Ongena, Popov and Udell (2013), who consider a number of mechanisms which can explain potential effects of home country lending standards on banks' cross-border activities. In response to tighter lending standards, banks may adopt a more conservative approach to lending at home, which they then pass on to their foreign affiliates. Foreign banks' branches and subsidiaries may also adopt less risky lending strategies for reputational reasons; the perception of bad risk management at an affiliate may have a negative impact on the reputation of the parent bank. Conversely, multinational banks subject to tighter lending standards might try to employ riskier lending strategies in foreign markets to compensate for their inability to extract higher returns from riskier borrowers at home.

Ongena, Popov and Udell (2013) find support for the latter hypothesis; multinational banks subject to tighter regulation at home engage in riskier lending in foreign markets. This finding does not necessarily suggest that foreign banks increase the quantity of lending in the host countries following a tightening of regulation at home, since banks adopting a riskier lending approach could substitute lending to riskier borrowers for less risky borrowers. However, it is likely that by being able to lend to a wider pool of borrowers foreign banks' lending in foreign markets will increase.

As in the case of capital requirements, we could expect lending standards to have a stronger effect on foreign banks' branches. However, in contrast to capital regulation, lending standards regulation applies to specific domestic products and is not applied to the balance sheet of the consolidated group. For example, countries often impose loan-to-value limits on all domestic mortgages (sometimes even within a specific area of the country). In addition, lending standards, unlike capital requirements, incentivise the parent bank to increase its lending in foreign markets. In other words, a tightening of capital requirements may increase constraints (if the Modigliani-Miller theorem is violated, as discussed) whereas a tightening of lending standard regulations may actually loosen constraints on lending in foreign markets. Given that a parent banks' balance sheet is unaffected in terms of compliance with tighter lending standards by risk taking of their foreign affiliates, it is possible that the parent bank will allow both branches and subsidiaries to provide lending to a wider pool of borrowers and increase lending. Also, convincing subsidiaries' boards of directors to increase lending may be potentially easier than convincing it to reduce lending. Therefore, we would expect weaker differential effects in the case of a loosening of constraints. It is consequently possible that both types of foreign affiliates will respond to tightening of lending standards in a very similar manner.

2.3 Reserve requirements hypothesis

Finally, our paper evaluates the effect of reserve requirements on multinational banks' cross-border lending. According to the "bank lending view" of monetary transmission, increasing reserves should result in credit supply

contractions (Kashyap and Stein, 2000).[9] An increase in the reserve requirements acts as an implicit tax because the interest rates central banks pay on reserves held by banks are often below market rates. As a result of a tightening of reserve requirements it is likely that we would observe an increase in the loan-deposit rate spread, and consequently a fall in aggregate lending. Additionally, higher reserves mean banks have fewer funds available to lend, which can directly affect banks' lending provision.[10] Mora (2014) provides empirical evidence for the effect of reserve requirements on banks' lending.[11]

Considering that the liabilities of foreign branches are on the balance sheet of the parent bank, it is likely that branches of foreign banks operating in the UK will also increase their loan-deposit rate spreads in response to higher reserve requirements in their home countries. Higher cost of credit for UK borrowers should therefore result in a reduction of lending provided by branches, relative to subsidiaries of foreign banks. Alternatively, parent banks might attempt to absorb the effect of higher reserve requirements by relying on internal capital markets (Mora, 2014).[12] Providing funds to parent banks might have an adverse effect on the ability of foreign affiliates to sustain lending in the host country at the same level. Since capital flows between the parent bank and its affiliated branches are subject to lower constraints compared to subsidiaries, we would expect foreign branches to be more active in smoothing reserve requirements' shocks to their parent institutions, and we therefore expect them to cut down lending to UK borrowers more relative to subsidiaries.

However, in normal times, parent banks are likely to be able to access wholesale markets to substitute the lost liquidity, which may make detecting absolute and differential effects of reserve requirements tightening on foreign affiliate lending unlikely.

2.4 Data description

We use data from a number of sources to test these hypotheses. Lim et al. (2011), Borio and Shim (2007) and Kuttner and Shim (2013) are the main sources of information on macroprudential policy actions. Data from these sources are supplemented with hand-collected information from searches of regulators' websites and financial stability reports, and from communication with relevant authorities. This allows us to build a dataset containing information on 191 changes to macroprudential policies over the period 1997 to 2014. Although the early time period mainly covers actions taken in emerging economies, advanced economies have been more active in taking macroprudential actions since the global financial crisis. The dataset covers a wide range of macroprudential actions. We cover any action which is 'macroprudential'-like, rather than focusing on actions which have been

[9] In a more recent paper, Kashyap and Stein (2012) develop a theoretical model which shows that the central bank can control credit supply by increasing or decreasing the quantity of reserves in conjunction with adjusting interest rate on reserves.
[10] Reserve requirements are often employed by the regulators in emerging markets as a macroprudential tool. Reinhart and Reinhart (1999), Montoro and Moreno (2011), Terrier et al. (2011) suggest that regulators prefer to vary reserves requirements to tap credit supply rather than increase the interest rates as the later might attract capital inflows and lead to depreciation of the domestic currency.
[11] Mora (2014) exploits an increase in reserve requirements in Lebanon which disproportionally affected deposits denominated in different currencies. Deposits denominated in foreign currency were subject to higher reserve requirements, relative to domestic currency deposits. Results show that this increase in required reserves had more adverse effects on lending provided by banks relying on funds denominated in foreign currency.
[12] This reasoning is in line with the results provided by Cetorelli and Goldberg (2012). They show that multinational banks mitigate domestic liquidity shocks via a cross-border flow of funds within the organization.

specifically taken for macroprudential purposes. In our analysis, we exploit information on adjustments to capital requirements, reserve requirements and lending standards.[13] Information on capital requirements includes changes in the level of both overall capital requirements and sector specific capital requirements such as changes in risk weights. Lending standards encompass changes to loan-to-value ratios, loan/debt-to-income ratios, and other changes in underwriting standards. We are also able to observe changes in reserve requirements which traditionally are not considered to be a macroprudential tool, but they are often used for financial stability purposes and are therefore likely to have macroprudential consequences.

To estimate the effect of these regulatory changes on the scale of banks' business activities via their multinational operations, we use quarterly banks' balance sheet information provided by the Bank of England. This dataset contains financial information for all banks operating in the UK between 1997q4 and 2014q1. We use data on lending provided by foreign banks' branches and subsidiaries and we are able to distinguish between the lending provided to other banks (Interbank lending) and non-banks (Non-bank lending). We also obtain country-level information provided by the International Monetary Fund's World Economic Outlook and the Bank of International Settlements. Specifically, we retrieve data on quarterly GDP growth rates, household debt, and level of domestic lending provided by domestic banks in each country in our sample.

Financial data are available for 15,148 observations for 497 foreign banks (both branches and subsidiaries) operating during our sample period. We map regulatory data into this dataset and restrict our sample to institutions which belong to a banking group operating at least one branch and subsidiary over the sample period. This is crucial for our identification strategy because it allows us to control for banking group-time-varying factors affecting lending by branches and subsidiaries of these groups in the UK. However, it also restricts our sample size to 4,107 observations. The number of banks in our final sample is reduced to 103 banks which belong to 38 banking groups (51 branches and 52 subsidiaries). These banks however, account for approximately 75% of the total foreign banks' assets in the UK. We also observe 40% of all of the macroprudential regulatory changes in our original dataset. Our sample includes 19 cases of capital requirements tightening, 23 cases of lending standards tightening and 35 cases of reserve requirements tightening.

Table 1 shows summary statistics for our dependent and explanatory variables as well as timing of regulatory changes. Panel A of Table 1 shows that banks included in the final sample are very similar in terms of dependent and explanatory variables to all foreign banks operating in the UK during the sample period, which allows us to believe the final sample of foreign banks is a good representation of all foreign institutions operating in the UK during this time period.

[13] Other types of macroprudential regulation do not vary sufficiently over time during our sample period and therefore are excluded from the analysis.

Table 1
Sample representativeness and summary statistics

Panel A: Sample representativeness

	All banks		Banks in the sample	
	Observations	*Mean*	*Observations*	*Mean*
Non-bank lending growth	15,148	0.023	4,107	0.035
Interbank lending growth	15,148	0.044	4,107	0.050
Bank size (ln total assets)	15,148	14.084	4,107	15.216
Interbank share	15,148	0.729	4,107	0.672

Panel B: Regulatory changes and number of banks

	Total	*Included in the sample*
Capital requirements tightening	43	24
Lending standards tightening	75	25
Reserve requirements tightening	73	38
All foreign banks	497	103
Foreign banks' branches	321	51
Foreign banks' subsidiaries	176	52

Panel C: Summary statistics

Variable	***N***	***Mean***	***SD***	***Min***	***Max***	***Source***
Dependent variables						
Non-bank lending growth	4,107	0.035	0.243	-0.42	0.62	Bank of England
Interbank lending growth	4,107	0.050	0.306	-0.51	0.89	Bank of England
Regulatory dummies						
Capital requirements tightening	4,107	0.006	0.078	0	1	IMF/BIS
Lending standards tightening	4,107	0.015	0.124	0	1	IMF/BIS
Reserve requirements tightening	4,107	0.009	0.097	0	1	IMF/BIS
Control variables						
Bank size (ln total assets)	4,107	15.216	2.250	6.03	20.21	Bank of England
Interbank share	4,107	0.672	0.320	0.02	0.97	Bank of England
GDP growth	4,001	2.097	2.312	-1.965	6.074	IMF/BIS
Household debt (ln)	4,001	0.929	0.458	0.266	1.912	IMF/BIS
Domestic lending (ln)	4,001	1.048	0.613	0.367	2.236	IMF/BIS

Panel D: Timing of changes to macroprudential regulation

Capital requirements		**Lending standards**		**Reserve requirements**			
Country	*Quarter*	*Country*	*Quarter*	*Country*	*Quarter*	*Country*	*Quarter*
Australia	1998q3	Portugal	1998q4	Philippines	1998q2	China	2007q4
South Africa	1998q4	Portugal	1999q1	France	1998q4	India	2007q4
Philippines	1998q4	China	2001q1	Philippines	1998q4	China	2008q1[a]
China	2002q1	Ireland	2001q4	Germany	1999q1	China	2008q2[a]
Australia	2004q4	China	2003q2	Portugal	1999q1	India	2009q4[a]
India	2004q4	Italy	2004q1	France	1999q1	India	2010q1
India	2005q1	China	2004q3	Spain	1999q1	China	2010q1
India	2005q3	China	2005q1	Greece	1999q3	India	2010q2
India	2005q4	Greece	2005q4	Italy	2000q1	China	2010q2
Ireland	2006q1	China	2006q1	France	2000q1	China	2010q4
Ireland	2006q2	China	2006q2	Ireland	2000q1	China	2011q1
India	2006q2	France	2007q1	Germany	2000q1	China	2011q2
India	2006q3	Canada	2008q4[a]	Greece	2000q2	China	2011q3
India	2006q4	China	2009q4[a]	India	2000q3		
India	2007q1	India	2010q1	Greece	2001q1		
Italy	2007q1	China	2010q1	China	2003q3		
Spain	2008q1[a]	Canada	2010q2	China	2004q2		
Spain	2008q2[a]	Canada	2011q1	India	2004q3		
India	2008q2[a]	Canada	2011q2	Switzerland	2005q1		
Switzerland	2009q1[a]	Canada	2011q4	China	2006q3		
India	2009q4[a]	India	2011q4	China	2006q4		
India	2010q3	Canada	2012q3	China	2007q1		
India	2010q4	Canada	2013q1	India	2007q1		
Switzerland	2012q2	China	2013q1	China	2007q2		
		USA	2014q1	China	2007q3		

Notes. Table 1 presents summary statistics for our sample and information on the timing of changes to macroprudential regulation. [a)] Excluded from the main analysis due to occurrence during the crisis period.

3. Identification strategy

3.1 Overall effect

We exploit cross-country cross-time variation in the tightening of macroprudential regulation and rely on difference-in-differences estimations. We begin by examining the overall effect of tighter capital requirements, lending standards and reserve requirements. We test if more stringent macroprudential regulation affects multinational banks' lending in the host country irrespective of their organizational form.

Although this analysis is not the central point of this paper, it allows us to establish whether macroprudential regulation tightening has an absolute effect on banks' cross-border lending. This is important, since a decrease in lending provided by branches might be offset by an increase in lending provided by subsidiaries (or vice versa), in which case the net effect of these regulatory changes could be insignificant.

We compare changes in the evolution of lending prior to and following the introduction of the change to macroprudential regulation between the treatment and control group. The treatment group consists of multinational banks operating in the UK which are subject to higher capital requirements and reserve requirements, and stricter lending standards imposed in their home countries. The control group includes foreign banks from countries which do not alter macroprudential regulation during our sample period. We estimate the following model:

$$\Delta y_{ijkt} = \alpha_i + \beta(Regulation_{kt}) + \varphi BC_{it} + \delta CC_{kt} + \gamma_i + \gamma_t + \varepsilon_{ijkt,} \quad , \qquad (1)$$

where Δy_{ijkt} denotes the percentage point change in lending by bank i, which is part of banking group j, from country k, in quarter t. The main explanatory variable *Regulation* takes a value of 1 for quarters and countries when a tightening of macroprudential regulation took place and 0 otherwise. The coefficient β provides information on the response of both branches and subsidiaries to changes in macroprudential regulation.

These regressions include bank-time varying control variables, a proxy for the size of the institution *(log of total assets: Bank size (ln))* and a proxy that controls for the differences in banks' business models *(share of interbank lending: Interbank share)*, denoted by BC_{it}. Bank size captures the fact that large banks both benefit from implicit guarantees but also have a bigger investor and asset base to draw on when raising capital. The interbank share allows us to control for the level of interbank loans provided by both branches and subsidiaries. This is important since reductions surrounding one type of lending following a tightening of macroprudential regulation could be partly driven by the level of this lending.

In addition to bank-time varying variables, we include country-time varying factors which are likely to affect multinational banks' cross-border lending, denoted by CC_{it}. We control for countrys' GDP growth, level of household debt and total domestic lending provided by domestic banks. These proxies allow us to control for demand conditions in the home countries of the banks included in the sample. Each regression includes a set of bank (γ_i) and quarter (γ_t) dummy variables to control for all bank time invariant factors**,** such as differences in banks business model, and time-varying bank-invariant factors, controlling for example for business cycles.

3.2 Main analysis: Differential effects

The core part of our analysis again relies on difference-in-difference estimations and compares changes in the evolution of lending prior to and following the introduction of the change to macroprudential regulation between treatment and control group. Here however, the treatment group consists of foreign branches affected by the change in macroprudential regulation. The control group consists of foreign subsidiaries affected by tighter macroprudential regulation, as well as subsidiaries and branches of banks whose home country regulators did not introduce changes to macroprudential regulation.[14] To test for the existence of differential effects we estimate the following model:

$$\Delta y_{ijkt} = \alpha_i + \beta(Regulation_{kt} * Type_{ijk}) + \varphi BC_{it} + \gamma_i + \gamma_{jkt} + \varepsilon_{ijkt,} \qquad (2)$$

where Δy_{ijkt} denotes the percentage point change in lending by bank i, which is part of banking group j, from country k, in quarter t. The main explanatory variable is an interaction term between the dummy variable *Regulation* and dummy variable *Type. Regulation* takes a value of 1 for quarters and countries when a tightening of macroprudential regulation took place, and 0 otherwise.[15] *Type* takes value of 1 for branches of foreign banks, and a value of 0 for subsidiaries. The coefficient β provides information on the difference in the response between branches and subsidiaries to changes in macroprudential regulation.

Our regressions include two bank-time varying control variables denoted by BC_{ijkt}. Specifically, we control for the size of foreign affiliates using log of total assets (*Bank size (ln)*) and differences in the bank type business models, including the share of interbank lending of each foreign affiliate (*Interbank share*).

The volume of credit provided by foreign affiliates of multinational banks will depend on the decisions and strategy of their parent banks. Therefore, to identify heterogeneous effects of regulatory changes on lending provided by branches and subsidiaries, we need to control for all the factors affecting parent banks (i.e. demand for parent bank products in the home market, strength of parent banks' balance sheets, or macroeconomic conditions in the home market). Focusing our analysis on branches and subsidiaries belonging to the same banking groups allows us to introduce banking group-time-varying fixed effects, γ_{jkt}, which eliminate all time varying parent bank-specific and home country-specific sources of unobserved heterogeneity. Additionally, we also control for all time invariant bank-specific factors including bank fixed effects, γ_i.

3.2 Difference-in-difference assumptions

The difference-in-difference estimates are valid under two assumptions. The first is that the treatment event, a change in macroprudential regulation policy is exogenous. In other words, changes in macroprudential regulation in

[14] In Table 11 Panel A we show results of tests with an alternative control group. This alternative control group is restricted to include of only subsidiaries of foreign banks operating in the UK which were subject to tighter macroprudential regulation introduced in their home countries. These results are identical to the ones obtained with a full sample.

[15] In unreported tests we use an alternative Regulation variable, taking values of -1 if regulation is loosened in country k at time t, and 0 otherwise. We do not observe in our sample loosening of capital requirements nor lending standards. However, we do observe 4 cases of reserve requirements loosening. Accounting for loosening cases in our specification yields exactly the same results, which are available upon request.

the home country should not depend on the lending provided by foreign branches and subsidiaries in the UK. The second, (the parallel trends assumption) is that the evolution of lending growth in treatment and control groups is similar prior to the change in the macroprudential regulation. This assumption allows us to believe that absent changes in macroprudential regulation both branches and subsidiaries' lending would continue to evolve in a similar way and any divergences in lending are due to changes in regulation. In this section we discuss results of tests providing support for the validity of both assumptions.

3.2.1 Treatment exogeneity assumption

To formally test whether macroprudential policies at home are not driven by lending growth abroad, we use linear probability model estimations. We examine whether lending provided by foreign banks' branches and subsidiaries in the UK, increases or decreases the probability of observing changes in the stringency of macroprudential regulation in the country of origin of their parent bank. To perform this analysis, we collapse our data at the country-level and model the likelihood of the home country of the parent bank tightening its regulation as a function of mean lending growth of foreign branches and subsidiaries abroad. Given that we are interested in exploring whether macroprudential regulation differentially affects lending provided by branches and subsidiaries of foreign banks in the UK, we also test whether the differences in lending growth rates between these two types of institutions affect the probability of observing changes in macroprudential regulation. To perform this analysis, we calculate the difference between mean lending growth provided by branches and subsidiaries in the year of regulatory change and three periods preceding these regulatory changes. Next, we again collapse our data on the country-level. If our assumption is valid, we expect lending growth by foreign branches and subsidiaries (in absolute terms and differences) not to impact the probability of the home country tightening its prudential policies.

Table 2 presents the results. Panel A shows the results of regressions where we include the contemporaneous and three lags of the mean lending growth rates. Panel B presents the results of regressions including the contemporaneous and three lags of the mean differences in lending growth rates.[16] Across all specifications, the coefficient on the main variables of interest remains statistically indistinguishable from zero, suggesting that neither the volume of banks' cross-border lending, nor the difference in the volume of cross-border lending provided in the UK by foreign banks' branches and subsidiaries, play significant role in the bank regulators' decision to change macroprudential regulation.[17]

3.2.2 Parallel trends assumption

To test the parallel trends assumption, we begin with a graphical illustration presented in Figure 2. In each of the graphs we plot the development in the mean lending growth for both types of institutions over the three quarters preceding each change in macroprudential regulation. Foreign banks' branches' lending growth is denoted by a

[16] Including a higher number of lags also yields insignificant results.
[17] In addition, we also estimate these regressions using complementary log-log regressions and logit regressions. Results of these regressions are again insignificant and are available upon request.

blue solid line and triangles, whereas the trend in the lending growth of foreign banks' subsidiaries is denoted by a red dashed line.

Table 2
Simultaneity bias tests

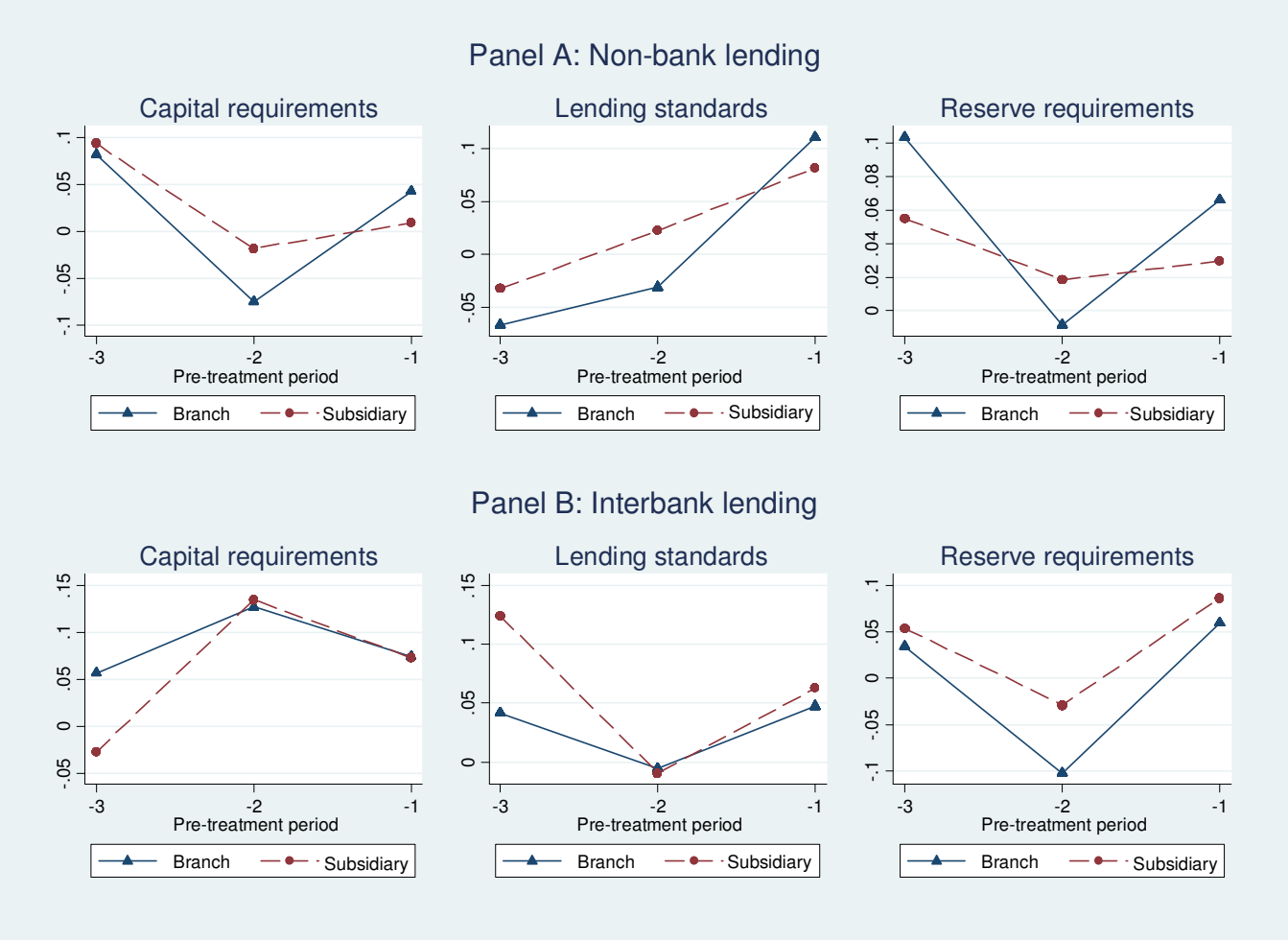
Panel A: Effect of average bank lending									
	Capital requirements tightening			**Lending standards tightening**			**Reserve requirements tightening**		
Non-bank lending (*t*)	-0.000	-0.000		-0.001	-0.000		-0.000	-0.000	
	(-0.11)	(-0.18)		(-1.11)	(-0.85)		(-0.23)	(-0.17)	
Non-bank lending *(t-1)*	-0.000	-0.000		0.000	0.000		0.000	0.000	
	(-0.52)	(-0.57)		(0.52)	(0.13)		(0.87)	(0.83)	
Non-bank lending *(t-2)*	-0.001	-0.001		-0.000	-0.000		0.000	0.000	
	(-0.88)	(-0.88)		(-0.68)	(-0.76)		(0.42)	(0.38)	
Non-bank lending *(t-3)*	-0.000	-0.000		-0.000	-0.000		-0.000	-0.000	
	(-0.59)	(-0.60)		(-1.30)	(-1.28)		(-0.41)	(-0.41)	
Interbank lending *(t)*	0.000		0.000	0.000		0.000	0.002		0.002
	(0.08)		(0.14)	(0.04)		(0.05)	(1.19)		(1.18)
Interbank lending *(t-1)*	0.000		0.000	0.001		0.001	-0.000		-0.000
	(0.46)		(0.48)	(0.29)		(0.32)	(-0.10)		(-0.09)
Interbank lending *(t-2)*	0.000		0.000	-0.002		-0.002	-0.000		-0.000
	(1.18)		(1.24)	(-1.58)		(-1.51)	(-0.09)		(-0.07)
Interbank lending *(t-3)*	0.000		0.000	0.003		0.003	0.001		0.001
	(0.11)		(0.20)	(1.26)		(1.34)	(0.73)		(0.60)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	791	791	791	791	791	791	791	791	791
R-squared	0.219	0.219	0.219	0.170	0.166	0.168	0.219	0.218	0.219
Panel B: Effect of the difference between average lending provided by branches and subsidiaries									
	Capital requirements tightening			**Lending standards tightening**			**Reserve requirements tightening**		
Non-bank lending (*t*)	0.031	0.032		0.003	0.004		0.013	0.012	
	(1.08)	(1.09)		(0.14)	(0.20)		(0.54)	(0.46)	
Non-bank lending *(t-1)*	0.020	0.018		0.031	0.033		0.017	0.016	
	(1.05)	(0.96)		(1.01)	(1.10)		(0.54)	(0.54)	
Non-bank lending *(t-2)*	0.007	0.007		-0.001	-0.001		0.006	0.008	
	(0.70)	(0.64)		(-0.13)	(-0.10)		(0.33)	(0.45)	
Non-bank lending *(t-3)*	-0.016	-0.019		-0.011	-0.012		0.022	0.020	
	(-1.07)	(-1.27)		(-1.25)	(-1.08)		(1.55)	(1.50)	
Interbank lending *(t)*	0.024		0.026	-0.010		-0.011	0.008		0.005
	(1.30)		(1.33)	(-0.57)		(-0.60)	(0.34)		(0.25)
Interbank lending *(t-1)*	0.016		0.018	-0.008		-0.005	-0.002		-0.002
	(1.31)		(1.41)	(-0.42)		(-0.31)	(-0.10)		(-0.11)
Interbank lending *(t-2)*	0.016		0.015	-0.008		-0.007	0.028		0.026
	(1.03)		(1.05)	(-0.52)		(-0.46)	(0.77)		(0.73)
Interbank lending *(t-3)*	0.023		0.021	-0.045*		-0.046*	0.010		0.010
	(1.30)		(1.24)	(-2.28)		(-2.32)	(0.28)		(0.27)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	791	791	791	791	791	791	791	791	791
R-squared	0.232	0.226	0.224	0.175	0.166	0.174	0.223	0.223	0.218

Notes. Table 2 presents results of Linear Probability Model where the dependent variable is a dummy variable equal to 1 if tightening of Capital requirements, Lending standards or Reserve requirements takes place in country i in quarter t. Explanatory variables include mean interbank and non-bank lending provided by banks from country i in the UK (Panel A) or difference in the mean interbank and non-bank lending provided by branches and subsidiaries. Each regression includes contemporaneous and three lags of main explanatory variables. Control variables include mean total assets and share of interbank loans of foreign banks' branches and subsidiaries operating in the UK. Additionally, regressions include country and quarter fixed effects. Standard errors are clustered at the country level. Robust t-statistics in parentheses. *** p<0.01 ** p<0.05, * p<0.10.

Panel A illustrates the evolution in lending to non-bank borrowers (Non-bank lending) and Panel B illustrates the evolution in interbank lending. In most cases, growth of lending provided by branches and subsidiaries exhibits a very similar pattern, suggesting that the parallel trends assumption is met. Note that this assumption does not require identical levels of lending growth between treatment and control groups as they are differenced out. In other

words, this assumption requires a similar trend in the growth rates of our dependent variables; however, it does not require growth rates to be at the same level (Lemmon and Roberts, 2010).

Figure 2
Parallel trends assumption



Notes: Figure 2 illustrates the behaviour of quarterly changes in the dependent variables for three quarters preceding changes in macroprudential regulation tightening. Branches of foreign banks (the treatment group) are represented by a triangle and solid line, whereas foreign banks' subsidiaries (the control group) are depicted by a dashed line. Non-bank lending refers to foreign banks' lending to the private non-bank UK sector and interbank lending to foreign banks' interbank lending in the UK.

As an additional check, we follow Lemmon and Roberts (2010) and conduct t-tests for the differences in the changes of quarterly growth rates of interbank and non-bank lending provided by branches and subsidiaries of foreign banks in the UK. We compare the difference in the changes of quarterly growth rates in three quarters preceding the implementation of tighter capital requirements, lending standards or reserve requirements. A lack of statistically significant differences in the evolution of lending growth rates between subsidiaries and branches prior to regulatory changes would strengthen our inferences from the visual inspection in Figure 2.

Table 3 shows the results of these tests for three quarters prior to changes to capital requirements (Panel A), lending standards (Panel B) and reserve requirements (Panel C). In each panel, we compare growth rates of both lending categories. In all but one case these differences are not significantly different from zero. This suggests that prior to regulatory changes, the evolution in foreign banks' lending does not vary with the organizational form of the

institution. Therefore, as discussed, we could expect that the potential differences are the result of changes in the macroprudential regulation rather than pre-treatment trends in the evolution of lending stemming from individual characteristics of branches and subsidiaries (e.g. different business models).

Table 3
Parallel trends assumption

Panel A: Capital requirements									
	Period t-3			**Period t-2**			**Period t-1**		
	Difference	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*
Non-bank lending growth	-0.011	-0.92	0.36	0.005	0.29	0.77	-0.008	-0.29	0.82
Interbank lending growth	-0.021	-1.80	0.03*	-0.002	-0.15	0.98	-0.027	-0.87	0.39
Panel B: Lending standards									
	Period t-3			**Period t-2**			**Period t-1**		
	Difference	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*
Non-bank lending growth	-0.015	-0.86	0.18	-0.005	-0.57	0.56	-0.021	-1.66	0.11
Interbank lending growth	-0.012	-1.18	0.14	-0.004	-0.25	0.31	-0.008	-0.69	0.67
Panel C: Reserve requirements									
	Period t-3			**Period t-2**			**Period t-1**		
	Difference	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*
Non-bank lending growth	-0.037	-1.75	0.19	0.007	0.47	0.55	-0.024	-1.55	0.15
Interbank lending growth	-0.006	-0.42	0.62	-0.021	-1.25	0.16	-0.022	-1.41	0.17

Notes. Table 3 presents the results of t-tests examining parallel trends assumption. We test for the differences in mean lending growth rates (both interbank and Non-bank lending) in three quarters preceding tightening of capital requirements (Panel A), lending standards (Panel B) and reserve requirements (Panel C). *** p<0.01 ** p<0.05, * p<0.1.

4. Results

4.1 Overall effect results

Table 4 presents the results for the effect of macroprudential regulation tightening on foreign banks' lending in the UK irrespective of their organizational form, obtained using equation 1. We remove the years 2008 and 2009 to avoid our estimates being driven by an extraordinary high frequency of regulatory changes during the crisis period.[18] We winsorize all variables at the 5th and 95th percentile. We cluster standard errors at the institutions' home country level to account for serial correlation within each panel (Bertrand, Mullainathan, and Duflo, 2004).

We find that changes in lending standards positively affect foreign multinational banks' lending to the UK's non-bank borrowers. Following tightening of lending standards, foreign banks increase their lending to non-bank borrowers by 5.9 pp. This finding is in line with the results obtained by Ongena, Popov and Udell (2013) who found that stricter lending standards in the home country are associated with laxer lending standards of multinational banks' in host countries. The fact that banks are lending to riskier borrowers, and therefore a wider pool of borrowers makes it plausible that multinational banks increase their overall lending output in the host countries.

Table 4 also reports a statistically significant effect of capital requirements tightening on interbank lending. We find that foreign banks operating in the UK reduce their lending to other banks operating in the UK by approximately 8.2 pp. We find that lending standards and reserve requirements have no effect on banks' cross-

[18] We also performed our tests including the crisis period and the results are very similar to those presented in the paper.

border lending. A significant effect of capital requirements tightening on foreign banks' lending to other banks is consistent with other findings in the literature such as Aiyar, Calomiris, Hooley, Korniyenko and Wieladek (2014) who document a significant reduction in lending for banks but not to non-banks following an increase in capital requirements. We conjecture that this is because non-bank lending is more likely to be relationship-based and more profitable. Reducing non-bank lending may hamper lending relationships which may be costly for banks, and therefore institutions subject to tighter capital requirements may refrain from reducing non-bank loans.[19] In contrast, banks are generally able to substitute funding in the interbank market easily; this means that any attempt to pass on increased capital costs by an affected branch will be swiftly met by a bank finding an alternative lender, while a subsidiary will be less affected by the increased cost and so banks are less likely to find an alternative source of borrowing. Additionally, interbank lending is typically of shorter maturity than lending to non-bank borrowers, which also allows banks to adjust this type of lending more quickly.[20]

Table 4
Macroprudential regulation and banks' cross-border lending

	Non-bank lending				Interbank lending			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Capital regulation	0.036	0.037			-0.082**	-0.082**		
	(1.69)	(1.72)			(-2.46)	(-2.41)		
Lending standards	0.059**		0.060**		0.013		0.013	
	(2.54)		(2.61)		(0.64)		(0.63)	
Reserve requirements	0.018			0.022	0.020			0.020
	(0.43)			(0.52)	(0.47)			(0.47)
Bank size (ln)	-0.002	-0.002	-0.002	-0.002	0.027**	0.028**	0.028**	0.027**
	(-0.23)	(-0.26)	(-0.23)	(-0.26)	(2.70)	(2.72)	(2.72)	(2.71)
Interbank share	-0.213***	-0.211***	-0.213***	-0.211***	0.242***	0.243***	0.243***	0.243***
	(-8.70)	(-8.39)	(-8.56)	(-8.66)	(6.50)	(6.58)	(6.58)	(6.54)
GDP growth	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(1.32)	(1.35)	(1.41)	(1.45)	(1.20)	(1.20)	(1.03)	(1.02)
Household debt (ln)	-0.097	-0.097	-0.102	-0.100	-0.336*	-0.337*	-0.328*	-0.326*
	(-1.05)	(-1.00)	(-1.12)	(-1.03)	(-2.10)	(-2.12)	(-2.07)	(-2.04)
Domestic lending (ln)	0.032	0.030	0.036	0.033	0.428***	0.428***	0.420***	0.419***
	(0.42)	(0.37)	(0.49)	(0.42)	(4.89)	(4.87)	(4.77)	(4.71)
Observations	3,923	3,923	3,923	3,923	3,923	3,923	3,923	3,923
R-squared	0.076	0.074	0.075	0.074	0.074	0.074	0.074	0.074
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country

Notes. Table 4 presents results of difference-in-difference regressions examining the effect of macroprudential regulatory changes on the lending of foreign banks in the UK. We estimate the following model: $\Delta y_{ijkt} = \alpha_i + \beta(Regulation_{kt}) + \varphi BC_{it} + \delta CC_{kt} + \gamma_i + \gamma_t + \varepsilon_{ijkt}$. Our dependent variables include foreign banks' lending to the UK non-bank sector and foreign banks' interbank lending in the UK. All dependent variables are in percentage point growth rates. The main explanatory variable *Regulation,* a dummy for regulatory change, equal to 1 if regulation is tightened in country *i* at quarter *t*, and 0 for all other periods. The coefficient β provides information about the effect of macroprudential regulation tightening on foreign banks' lending in the UK irrespective of their organizational form. The set of bank-time varying control variables BC include the logarithm of banks' total assets (Bank size (ln)), and the share of interbank lending (Interbank share). Country-time varying control variables (CC) control for countrys' GDP growth, level of household debt, and total domestic lending provided by domestic banks. Additionally, regressions include bank and quarter fixed effects. All variables are winsorized at 5th and 95th percentile. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[19] Our argument that the lack of an effect on non-bank lending could be due to relationship lending is supported by the results presented in Table B.1. We interact Type, Regulation with the log of total assets, our proxy for size. We find that larger banks which are less likely to rely on soft information acquired through repeated interactions with the borrower reduce their interbank lending less than smaller institutions which operations are more likely to be relationship based. At the same time, larger banks are more likely to reduce non-bank lending more than smaller banks, however this this effect is not statistically significant. These results support the idea that the lack of a significant effect on non-bank lending is due to the fact that banks try to avoid damaging their relationships with borrowers. This hypothesis is also supported by the results presented in Panel A of Table 6. We show that banks whose business model relies more on the provision of non-bank lending (and therefore lending relationships) are more likely to contract their interbank lending exposures more than banks which business model relies on the provision of interbank loans.

[20] In Appendix B, Table B.2 we perform an additional analysis by looking at the response of foreign branches and subsidiaries to tighter capital requirements separately. We repeat the estimations in Table 4 but instead of including all institutions in the estimation, we first use a sample consisting of only branches and then repeat this for only subsidiaries. We find a negative and statistically significant effect of capital requirements tightening for the former group. The subsidiaries' response also seems to be negative although much smaller in magnitude and not statistically significant. We also find a positive effect of lending standards on lending to customers for both branches and subsidiaries. However, this effect is significant at 10% level only for branches of multinational banks.

4.2 Differential effects

Having discussed the absolute effect of macroprudential tightening, we now turn to the main analysis of this paper. Table 5 presents the results of tests examining the differential effect of macroprudential regulation obtained with Equation 2. In addition, we also perform an analysis where we substitute banking group-specific fixed effects with country-specific fixed effects (Column 1 and 6) to highlight the importance of controlling for banking group specific factors that are likely to affect our dependent variables. Each regression controls for the size of the institution measured as the logarithm of total assets (Bank size (ln)), and share of interbank loans to total loans (Interbank share). As above, we remove the years 2008 and 2009 to avoid our estimates being driven by an extraordinary high frequency of regulatory changes during the crisis period.

Columns 1 to 5 show the effect of changes in foreign banks' home country macroprudential regulation on lending provided by foreign branches and subsidiaries to the non-bank sector in the UK. Column 1 and 2 report regression results of the model, which includes interactions between the *Type* dummy and all the regulatory dummies. The coefficients show that following a tightening of capital requirements, branches reduce their lending growth by 7.3pp more relative to subsidiaries when we do not control banking group specific factors. However, t-statistics of -0.90 suggest that this effect is not statistically significant at any conventional level. When banking group-quarter fixed effects are included in the model, the effect is much weaker (2.1 percentage point reduction) and again statistically insignificant. Similarly, the t-statistic for the coefficients on the interactions between the Type and the lending standards and reserve requirements variables shows that the effect of these regulations cannot be distinguished from zero. The results in Column 1 and 2 are reinforced by the results in Columns 3-5, where we include interaction terms for each regulation individually in each regression. Again, none of the interaction terms exhibit statistically significant effects on non-bank lending growth.

In Table 4 we find that foreign banks' affiliates operating in the UK significantly increase their lending to non-bank borrowers, irrespective of their organizational form. However, in Table 5, we do not find support for the existence of differential effects for lending standards. Why might there be no differential effect? Lending standards regulation - unlike capital requirements - applies to specific domestic products and is not applied to the balance sheet of the consolidated group. Since parent banks' balance sheets remain unaffected (in terms of compliance with tighter lending standards) by risk taking of their foreign affiliates, it is possible that the parent bank will allow both foreign branches and subsidiaries to increase lending. Additionally, a tightening of lending standards, unlike capital requirements, appears to incentivise the parent bank to increase lending in foreign markets, which is evident from Table 4 (and supported by the evidence provided by Ongena, Popov and Udell (2013) as well as Hills, Reinhardt, Sowerbutts and Wieladek (2017). In other words, a tightening of capital requirements may increase constraints (if the Modigliani-Miller theorem is violated as discussed), whereas a tightening of lending standard regulations may actually loosen constraints. But, convincing subsidiaries' boards of directors to increase lending may be potentially easier than convincing it to reduce lending and we would thus expect weaker differential effects in the case of a loosening of constraints.

The coefficient in Column 2 of Table 5 suggests that the difference in magnitude of the coefficient on the interaction term between Lending standards and Type is economically insignificant (Coefficient: -0.001) which supports our hypothesis.

Table 5
Macroprudential regulation and banks' cross-border lending: Differential effects

	Non-Bank lending					Interbank lending				
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
Capital regulation*Type	-0.073	-0.021	-0.021			-0.044***	-0.057**	-0.058**		
	(-0.90)	(-0.35)	(-0.34)			(-3.70)	(-2.27)	(-2.50)		
Lending standards*Type	-0.046	-0.001		-0.001		0.005	0.024		0.025	
	(-0.45)	(-0.01)		(-0.01)		(0.19)	(0.59)		(0.59)	
Reserve requirements*Type	-0.005	-0.012			-0.012	0.068	0.092			0.092
	(-0.07)	(-0.12)			(-0.12)	(0.97)	(0.96)			(0.97)
Bank size (ln)	0.002	-0.002	-0.002	-0.002	-0.002	0.034**	0.032	0.032	0.031	0.032
	(0.16)	(-0.10)	(-0.10)	(-0.10)	(-0.10)	(2.61)	(1.34)	(1.35)	(1.35)	(1.34)
Interbank share	-0.239***	-0.247***	-0.247***	-0.247***	-0.247***	0.227***	0.214*	0.212*	0.211*	0.215*
	(-9.07)	(-6.48)	(-6.56)	(-6.53)	(-6.49)	(4.04)	(1.93)	(1.91)	(1.92)	(1.93)
Observations	4,107	4,107	4,107	4,107	4,107	4,107	4,107	4,107	4,107	4,107
R-squared	0.264	0.572	0.572	0.572	0.572	0.315	0.569	0.569	0.569	0.569
Group*Quarter FE	NO	YES	YES	YES	YES	NO	YES	YES	YES	YES
Country*Quarter FE	YES	NO	NO	NO	NO	YES	NO	NO	NO	NO
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country	Country	Country

Notes. Table 5 presents results of difference-in-difference regressions examining the differential effect of macroprudential regulatory changes on lending of foreign banks in the UK. We estimate the following model: $\Delta y_{ijkt} = \alpha_i + \beta(Regulation_{kt} * Type_{ijk}) + \varphi BC_{it} + \gamma_i + \gamma_{jkt} + \varepsilon_{ijkt}$. Our dependent variables include foreign banks' lending to the UK non-bank sector and foreign banks' interbank lending in the UK. All dependent variables are in percentage point growth rates. The main explanatory variable is an interaction term between *Regulation* and *Type*. *Regulation* is a dummy for regulatory change, equal to 1 if regulation is tightened in country *i* at quarter *t*, and 0 for all other periods. *Type* is a dummy variable equal to 1 if foreign bank operates in the UK as a branch, and 0 if it operates as a subsidiary. The coefficient β provides information about the effect of macroprudential regulation tightening. The set of bank-time varying control variables, BC include the logarithm of banks' total assets (Bank size (ln)), and the share of interbank lending (Interbank share). Additionally, regressions include bank fixed effects and banking group-quarter fixed effects. All variables are winsorized at 5th and 95th percentile. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Columns 5 to 8 show the results for the effect of macroprudential regulation on interbank lending provided by foreign banks in the UK. We first report the estimates for the tests where the interactions between *Type* and all three regulations are included simultaneously. We find heterogeneity in lending provided by branches and subsidiaries in response to changes in capital requirements. When we do not control for banking group specific factors, our results suggest that foreign banks' branches reduce lending to other banks operating in the UK by 4.4 pp more than subsidiaries following a tightening of capital requirements. This effect is significant at the 1% level (t-statistic of -3.70). Including banking group-quarter dummy variables increases the magnitude of the coefficient on the interaction term between *Capital requirements* and *Type* to 5.7 pp (coefficient -0.057). This suggests that foreign banks' branches reduce their interbank lending by 5.7 pp more than subsidiaries following a tightening of capital requirements. This effect is again significant, at 5% level (t-statistic of -2.27). The economic magnitude of this effect is also large. The mean interbank lending growth in our sample is 5pp. For a mean bank, the coefficient of -0.057 (or -5.7pp) translates into a reduction of interbank lending growth rate from 5pp to -0.7pp.

The remaining coefficients on reserve requirements and lending standards again lack statistical significance with t-statistics of 0.59 and 0.96, respectively. In columns 8 to 10, we report the estimates of regressions where the effect

of each regulatory change is evaluated individually. Estimates of these tests support the results in Column 7. The coefficient on capital requirements is again negative and statistically significant, whilst the coefficients for our two additional regulation variables remain indistinguishable from zero.

Among the control variables, we find that the size of the foreign affiliate does not influence lending, whereas the share of the interbank loans significantly correlates only with non-bank private sector loans. The negative sign of the coefficient suggests that a greater focus on interbank lending provision decreases the reduction in the growth rate of loans to the non-bank sector.

Our baseline results suggest that tighter capital regulation in the home country has a stronger effect on lending provided by multinational banks' branches compared to subsidiaries. These results are in line with our predictions. A greater degree of control by the parent bank over its affiliates operating in the form of a branch makes it easier to reduce the banking group's risk-weighted assets through contractions of branch lending. But we only find heterogeneity in the provision of interbank lending.

4.3 Transmission mechanism

The results in Table 5 show that foreign banks' branches reduce their interbank lending more than the subsidiaries of foreign banks in response to tightening of capital requirements in their parent bank country. Our presumption is that these differential effects may, at least in part, stem from parent banks' ability to easily and swiftly adjust the balance sheets of their foreign branches, relative to their subsidiaries. In the case of affiliates operating under a subsidiary structure, parent banks' decisions often require approval of subsidiaries' boards of directors. Given this, it is more difficult or time consuming for parent banks to influence lending decisions of subsidiaries to adapt to the new regulatory requirements. In this section, we provide evidence for the validity of our hypothesis.

To construct tests which support our presumption, we follow the literature on delegation of authority within firms, which predicts that in certain circumstances delegating authority may have beneficial effects for firms' performance. Aghion and Tirole (1997) consider delegation of authority to subordinates as an incentive mechanism for information production, particularly the production of 'soft' information. In their model, a principal (senior manager) has power to overturn the agents' (subordinates') decisions. However, the principal often refrains from exercising this power, and grants authority to subordinates who have better access to soft information to spur information production (Agrawal and Hauswald, 2010). We relate these predictions to financial intermediation, and in particular, multinational banks. In our context, we assume that parent banks delegate more decision making authority to their foreign affiliates, the more non-bank lending the banking group provides. This is because non-bank lending - unlike interbank lending - relies to a large extent on relationships between banks and borrowers, and thus relies on the collection of soft information (Berger, Miller, Petersen, Rajan and Stein, 2005; Berger and Udell, 2002; Stein, 2002). Conversely, parent banks will hold more decision making authority over the business activities of their foreign affiliates the more interbank lending they provide, and therefore the more they rely on hard information.

McAfee and McMillan (1995) consider that principals require time to supervise the actions of their subordinates. Since their time is limited, they will need to delegate some power to subprincipals. This implies that hierarchical structures, where at least part of the decision making power is delegated to subprincipals, could be more beneficial for banking groups which operate a higher number of foreign affiliates. Alonso, Dessein and Matouschek (2008) suggest that decentralisation could be beneficial for multidivisional corporations when coordination becomes important. These authors argue that companies with multiple divisions can benefit under decentralized decision making structures from improved communication, which in turn improves firm performance. Relating these predictions to our paper, delegation should be more pronounced in banking groups which operate more foreign affiliates.

Dessein (2002) suggests that delegating authority to subordinates allows companies to avoid noisy communication and loss of information which, in turn, subsequently improves decision making efficiency. In his model, principals and agents have different objectives (agents may be more short-term biased, or more risk averse). To meet their objectives, agents may miscommunicate information supplied to the principal, therefore generating noisy information and/or causing loss of information. To reduce this effect, principals may delegate more authority to the agent. Dessein's (2002) model predicts that the benefits of delegating authority outweigh the principal's loss of decision making control the more relevant is the information obtained by the agent.

In our context, we argue that the relevance of information about local market conditions in the UK obtained by foreign affiliates of multinational banks in the UK outweighs parent banks' loss of control involved with delegation of decision making authority to these foreign affiliates. This prediction is supported by the results in the empirical literature. Agarwal and Hauswald (2009) document that geographical proximity between the lender and the borrower improves collection of relevant information used by financial intermediaries for credit decisions. Landier, Nair and Wulf (2007) suggest that firms' geographical dispersion impedes flow of such information within the organization. Finally, Agarwal and Hauswald (2009) test the predictions in Aghion and Tirole (1997) and Dessein (2002), and document that headquarters of major U.S. banks delegate more decision making authority to their units operating in further geographical distance from the headquarter. The better the office is at obtaining the soft information, the more autonomous they are in credit decisions, and the more information they produce.[21] In sum, we expect the differential effects found in Table 5 to be stronger for banking groups located at further geographical distances from their parent bank's headquarters.

Three aspects relating to the delegation literature require further explanation if these are supposed to help us test for the transmission mechanism.

[21] Agrawal and Hauswald (2009) consider delegation of authority between banks' headquarters and their branches. The authors only have data for branches of these banks and therefore are not able to test this mechanism for subsidiaries. However, their results should apply even more to affiliated subsidiaries. Unlike branches, decisions regarding subsidiaries' operations are decided by the subsidiaries' boards of directors. Branch operations are directly overseen by the parent banks' boards. In addition, foreign subsidiaries in our sample mainly focus on provision of non-bank loans requiring collection of 'soft' information.

The first aspect relates to the fact that decision making authority can be delegated by the parent bank to foreign affiliates operating under a subsidiary as well as a branch structure. Williamson (1967) suggests that under more complex hierarchical structures, principals substitute information quality for information quantity. Because subsidiaries have their own boards of directors, their hierarchical structure is more complex relative to branches. Therefore, in line with Aghion and Tirole's (1997) and Dessein's (2002) predictions, multinational banks should find it more beneficial to delegate more autonomy to affiliated subsidiaries. Second, the above literature considers delegation to be advantageous mainly through improved collection and flow of soft information. In the case of financial intermediaries, such information is obtained through lending relationships attributed to non-bank lending. One could conjecture that delegation could affect banks' lending to non-financial borrowers to a greater extent. However, it is very unlikely that parent banks will delegate decision making authority to their foreign affiliates for only a subset of the lending operation that it does. The third aspect is the principal, in our case the parent bank always holds the right to reverse delegation. According to Hart and Holmstrom (2010) delegation is a commitment device, breaching which could have negative consequences, leading to aggravation among the subordinates and affect firms' performance. Therefore, the principal will refrain from reversing delegation. Knyazeva, Knyazeva and Masulis (2013) document that interfering in the independence of the board leads to adverse firm valuation and performance effects of subsidiaries. Therefore, it might be much costlier for the parent bank to overrule the decisions of subsidiaries' boards compared to branch managers.

Taking all these theoretical predictions and the empirical evidence together, we should observe stronger differential effects, as found in Table 5, for banking groups which rely more on non-bank lending, are operating in greater distance from their affiliates in the UK and banking groups which operate higher number of these affiliated institutions. Our strategy is to re-run Equation 1 on subsamples of our data. We split our sample into high and low share of non-bank loans, where banking groups with a share of non-bank lending above the median share for all banks fall into former category.[22] Banks belonging to banking groups operating more than 3 foreign affiliates in the UK (above 75th percentile) are classified as banking groups with high number of affiliates. Finally, banking groups where the distance between the parent bank headquarter and foreign affiliates location is above 75th percentile of distance for all banking groups are defined as high distance banking groups. To confirm whether the differences in the magnitude of coefficient for split samples significantly differ from each other, we construct three dummy variables for each sample split and interact it with our main interaction term (*Regulation*Type*). We include this triple interaction in equation 1. *Non-bank loans share* is a dummy variable which takes a value of 1 for banks from banking groups classified as groups with high share of non-bank lending, and zero otherwise. *Number of affiliates* is a dummy variable equal to 1 for banks which belong to banking groups operating high numbers of foreign affiliates, and zero otherwise. Finally, *Distance* is a dummy variable equal to 1 for banks where the distance between the parent bank headquarter and foreign affiliate is high, and zero otherwise.

[22] We split our sample at the median of non-bank lending share because splitting the sample at 75th percentile results in a sample where none of the banks are subject to tightening in macroprudential regulation.

Table 6 presents the results. For each test, we only present results where our dependent variable is the growth rate of interbank loans.[23] In Panel A we split banking groups according to the share of non-bank lending to total lending of all their affiliated institutions present in the UK. We find that differential effects of capital requirement tightening are stronger for banking groups with a high ratio of non-bank lending (High). In line with predictions in Williamson (1976) and Aghion and Tirole (1997), the autonomy of subsidiaries in these banking groups should be greater and therefore it will be more difficult for the parent bank to adjust their lending in response to tighter macroprudential regulation.

In Panel B, we split our sample according to the number of affiliates which banking groups operate in the UK. Banking groups operating more than three affiliates (above 75th percentile) again exhibit stronger differential effect relative to groups with lower numbers of affiliates. Again, these results suggest that the driving mechanism behind the results in Table 5 is the degree of control which parent banks hold over their branches compared to subsidiaries.

Finally, in Panel C of Table 6, we split the sample according to the geographical distance dividing banking groups headquarters and headquarters of their UK affiliates. Here we also find support for our proposed transmission mechanism. The coefficient on the interaction term in Equation1 is higher for the subsample of banking groups located further away from their UK subsidiaries and branches. In line with Williamson (1976), Dessein (2002) and Agarwal and Hauswald (2009), more distant subsidiaries should benefit from more decision making autonomy. In such case, it is again more difficult for parent banks to influence the asset side of their subsidiaries' balance sheets.

Triple interaction terms in Panels A, B and C of Table 6 confirm that the differences in magnitude of coefficients for each sample split are statistically significant. Overall, these results support our proposed transmission mechanism hypothesis, stating that the effect of tightening macroprudential regulation will be stronger for branches than subsidiaries due to higher degree of control which parent banks hold over the former type of institutions.

To provide more direct evidence for the existence of the proposed transmission mechanism, we perform one more test. We obtain information on the number of independent directors who sit on the boards of bank subsidiaries in our sample.[24] The Prudential Regulatory Authority in the UK and the Bank for International Settlements, advise banks to include a sufficient number of independent directors who should provide an impartial evaluation of any group level decisions affecting operations of a subsidiary and challenge decisions of executive directors (PRA, 2016; BIS, 2010). The intuition behind this test is that in institutions where there is a higher share of independent directors on the board, decision making process, regarding bank operations, will be more autonomous.[25] Therefore, we expect to observe a stronger differential effect in those groups in which board independence is higher, as the parent bank will have to reduce branch lending more in response to a tightening of capital requirements.

[23] Results for regressions with non-bank lending growth as a dependent variable are insignificant in each case and therefore we refrain from reporting them. These results are available upon request.
[24] Information on board composition is obtained from the BoardEx database. We were unable to obtain this information for all banks in our sample and therefore the number of observations in this test is lower than in all other tests.

Table 6
Transmission mechanism tests

Panel A: Sample split on the group share of non-bank lending			
	Dependent variable: Interbank lending		
Split variable: *Share of non-bank lending*	**-**	***High***	***Low***
Capital regulation*Type*Non-bank loans share	-0.025**		
	(-2.29)		
Capital regulation*Type	-0.036***	-0.060**	-0.036***
	(-13.54)	(-2.34)	(-13.67)
Observations	4,107	1,956	2,151
R-squared	0.562	0.592	0.521
Controls	YES	YES	YES
Group*Quarter FE	YES	YES	YES
Bank FE	YES	YES	YES
Cluster	Country	Country	Country
Panel B: Sample split on the number of affiliates			
	Dependent variable: Interbank lending		
Split variable: *Number of affiliates*	**-**	***High***	***Low***
Capital regulation*Type*Number of affiliates	-0.040***		
	(-4.89)		
Capital regulation*Type	-0.041***	-0.082***	-0.039***
	(-4.65)	(-10.84)	(-8.99)
Observations	4,107	1,524	2,583
R-squared	0.565	0.422	0.670
Controls	YES	YES	YES
Group*Quarter FE	YES	YES	YES
Bank FE	YES	YES	YES
Cluster	Country	Country	Country
Panel C: Sample split on distance between parent bank headquarter and foreign affiliate			
	Dependent variable: Interbank lending		
Split variable: *Distance to parent banks headquarter*	**-**	***High***	***Low***
Capital regulation*Type*Distance	-0.038**		
	(-2.33)		
Capital regulation*Type	-0.045**	-0.083***	-0.045**
	(-2.77)	(-15.36)	(-2.79)
Observations	4,107	1,162	2,945
R-squared	0.562	0.601	0.543
Controls	YES	YES	YES
Group*Quarter FE	YES	YES	YES
Bank FE	YES	YES	YES
Cluster	Country	Country	Country
Panel D: Sample split on board independence index			
	Dependent variable: Board independence		
Split variable: *Board independence*	**-**	***High***	***Low***
Capital regulation*Type*Board independence	-0.059***		
	(-4.54)		
Capital regulation*Type	-0.025**	-0.087***	-0.032***
	(-2.24)	(-4.83)	(-4.14)
Observations	3,391	1,208	2,183
R-squared	0.555	0.547	0.564
Controls	YES	YES	YES
Group*Quarter FE	YES	YES	YES
Bank FE	YES	YES	YES
Cluster	Country	Country	Country

Notes. Table 6 presents results of regressions testing transmission mechanism behind the main results in Table 4. In each column Model 1 is estimated using subsamples. Reported are only results for regressions with Interbank loans included as the dependent variable. In Panel A the sample is split into banking groups with non-bank lending share of total loans above (High) and below (Low) the median of the share of all banking groups. In Panel B the sample is split into banking groups operating more than three institutions (above 75th percentile) in the UK (High) and less than four institutions (Low). In Panel C banking groups are divided according to the distance between headquarter of the banking group and headquarter of the affiliate banks operating in the UK. Banking groups located above 75th percentile of distance are included in the High distance group and banking groups located below the 75th percentile of the distance are included in the Low distance group. Finally, in Panel D banking groups are split based on the share of board members who are independent. Banking groups where the share of independent directors is above the median of this share for all banks are classified as highly independent banks (High) and banking groups where the share of independent directors is below the median are classified as less independent banks (Low) We also report results of regressions which include interaction terms between *Regulation, Type* and dummy variables equal to 1 if banks belong to banking groups: with high non-bank loans share (Panel A), operating high number of foreign affiliates (Panel B), banking groups with high distance dividing headquarters of the parent banks and its affiliated institutions operating in the UK; and banking groups with a higher share of independent directors on the board of directors (Panel D). All variables are winsorized at 5th and 95th percentile. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

We classify banks with the share of independent directors above the median share of independent directors in all financial institutions in our sample as banks with a highly independent board (High), the remaining banks are classified as those with a less independent board (Low).

Panel D of Table 6 shows the results. Again, we start by creating a triple interaction with the dummy denoting high or low board independence (the *Board independence* dummy variable is equal to 1 for highly independent boards, and 0 otherwise) and our main interaction term (*Regulation*Type*), and then we split the sample into two groups. We find that the differential response of banks' lending to tighter capital requirements is less pronounced in groups where the parent bank holds more control over its subsidiaries (board independence is lower) and stronger where the share of independent directors is higher and therefore the board is more autonomous.

4.3 Robustness tests

We run a number of robustness tests. Firstly, we examine if our results are driven or biased by events coinciding with changes in macroprudential regulation. Such events could bias the results to the extent to which they affect UK branches and subsidiaries of foreign banks differently. One type of event is a change in microprudential, bank-specific, capital requirements, of the sort examined in Aiyar, Calomiris, Hooley, Korniyenko and Wieladek (2014) Aiyar, Calomiris and Wieladek (2014). Banks subject to these requirements, include UK-owned banks and subsidiaries of foreign banks, but not branches of foreign banks. If a tightening of capital requirements in a given home country of a foreign bank overlaps with a tightening of capital requirements of its UK subsidiaries, then it is possible that the both branches and subsidiaries will reduce their lending. Such a situation is likely to render a downward bias on our treatment effect, since the differences in branches' and subsidiaries' lending growth around the change in macroprudential regulation will increase.

To test if our main results can be biased by such events, we exclude from our sample all subsidiaries which were subject to changes in bank-specific capital requirements. Table 7 presents the coefficients, which are slightly greater in magnitude compared to those in Table 5, indicating a downward bias. Importantly however, the differential effect of capital requirements on interbank lending is still statistically significant.

Table 7
Threats to identification: Subsidiaries subject to bank specific capital requirements removed

	Non-Bank lending		Interbank lending	
Capital regulation*Type	-0.029	-0.025	-0.066**	-0.075**
	(-0.41)	(-0.38)	(-2.38)	(-2.42)
Bank size (ln)	-0.004		0.032	
	(-0.14)		(1.35)	
Interbank share	-0.258***		0.208	
	(-5.85)		(1.70)	
Observations	3,882	3,882	3,882	3,882
R-squared	0.580	0.564	0.571	0.564
Group*Quarter FE	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES
Cluster	Country	Country	Country	Country

Notes. Table 7 presents results of difference-in-difference regressions, examining the effect of macroprudential regulatory changes on lending of foreign banks in the UK. We replicate the results presented in Table 5 with the sample excluding subsidiaries which are subject to changes in bank-specific capital requirements imposed by the Financial Services Authority. All variables are winsorized at 5th and 95th percentile. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Next, we perform three falsification tests to check whether differences between the growth of lending provided by branches and subsidiaries in Table 5 can be attributed to changes in macroprudential regulation or are driven by other factors, or chance. We run two Monte Carlo simulations with 1,000 replications, where first we randomly assign placebo treatment to branches affected by changes in regulation in their home markets but we pretend that these changes occurred in periods preceding their actual occurrence. In the second falsification test, we pretend that the change in macroprudential regulation affected branches from countries which never altered their macroprudential regulation. We estimate the following regression:

$$\Delta y_{ijkt} = \alpha_i + \beta(Placebo_{ijk}) + \varphi BC_{it} + \gamma_i + \gamma_{jkt} + \varepsilon_{ijkt}. \qquad (3)$$

where *Placebo* is a binary variable randomly set to 1 for banks in the treatment group (affected foreign banks' branches) in periods preceding actual change to macroprudential regulation, and later equal to 1 for banks in countries where no changes to macroprudential regulation occurred during our sample period. We repeat this process 1,000 times, saving the *p-value* on the coefficient β from each regression and compute the rejection rates of the null hypothesis $\beta=0$ at the 1%, 5%, and 10% levels. Because we know that placebo treatments should have had no effect in both tests, we know that the null of zero effect is true. We should therefore only reject the null by making Type I errors. The results of this exercise are shown in Panel A and Panel B of Table 8. The rejection rates for all dependent variables are in line with those that would occur through Type I errors. This analysis further strengthens our main results.

Table 8
Falsification tests

Panel A: Falsification test 1		**Panel B: Falsification test 2**		**Panel C: Falsification test 3**		
Number of replications: 1000		Number of replications: 1000		Variable	*Interbank lending*	*Non-bank Loans*
Interbank Lending	*Non-bank Loans*	*Interbank Lending*	*Non-bank loans*	Placebo *Capital requirements*	0.0301	-0.0192
					(0.35)	(0.56)
				Placebo *Lending standards*	0.0395	-0.0111
Rejection rates at 1% level (2-tailed test):		Rejection rates at 1% level (2-tailed test):			(1.15)	(0.96)
				Placebo *Reserve requirements*	-0.047	0.0252
1.00%	1.20%	1.10%	1.00%		(-0.24)	(0.02)
Rejection rates at 5% level (2-tailed test):		Rejection rates at 5% level (2-tailed test):		Controls	YES	YES
				Bank FE	YES	YES
4.70%	5.20%	4.40%	4.80%	Year FE	YES	YES
Rejection rates at 10% level (2-tailed test):		Rejection rates at 10% level (2-tailed test):				
				Observations	4,852	4,852
8.40%	9.50%	8.70%	9.20%	Cluster	0.077	0.132

Notes. Table 8 presents Monte Carlo simulations in Panel A and Panel B. We estimate the regression $\Delta y_{ijkt} = \alpha_i + \beta(Placebo_{ijk}) + \varphi BC_{it} + \gamma_i + \gamma_{jkt} + \varepsilon_{ijkt}$, where in Panel A, *Placebo* is a binary variable randomly set to 1 for banks in the treatment group (affected foreign banks' branches) in periods preceding actual change in macroprudential regulation. In Panel B, we randomly assign banks to placebo treatment status setting *Placebo* equal to 1 for banks in countries where no changes to macroprudential regulation occurred during our sample period. We estimate the regression and save the p-value on the coefficient β and repeat this process 1,000 times and compute the rejection rates of the null hypothesis $\beta=0$ at the 1%, 5%, and 10% levels. Panel C presents results of tests where we examine the effect of macroprudential regulation on UK-owned banks. Here, only UK-owned banks are included in the sample. We estimate the following regression $\Delta y_{it} = \alpha_i + \beta(Placebo_{it}) + \varphi BC_{it} + \gamma_i + \gamma_t + \varepsilon_{it}$, where our dependent variable denotes a growth rate in lending provided to non-bank borrowers (*Non-bank lending*) and other banks (*Interbank lending*). *Placebo* takes a value of one for periods in which variable $Regulation_{kt}$ in specification 1 is equal to 1, and 0 otherwise. We generate a Placebo variable for each type of macroprudential regulation. Regressions include variables controlling for the size of the institution and share of interbank loans on its balance sheet, and bank and quarter fixed effects. Standard errors are clustered at the banks' home country level. All variables are winsorized at 5th and 95th percentile. Robust *t*-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In our third falsification test, we want to observe if UK banks alter their lending during quarters in which changes to macroprudential regulation are taking place in other countries. Results of these tests are important for two

reasons. Firstly, finding significant effects would suggest that UK-owned banks' lending is also affected by changes to macroprudential regulation via reduced availability of interbank funds, which we document in Table 5. Secondly, given that banks can substitute interbank funds from affected institutions with funds from non-affected banks or with other type of funding significant results may also suggest that some other UK-specific factors may be coinciding with changes in macroprudential regulation in foreign markets. To this end, we construct a sample consisting of only UK-owned banks operating during our sample period and estimate the following model:

$$\Delta y_{it} = \alpha_i + \beta(Placebo_{it}) + \varphi BC_{it} + \gamma_i + \gamma_t + \varepsilon_{it}, \qquad (4)$$

where *Placebo* takes a value of 1 for periods in which variable *Regulation* in specification 1 is equal to 1, and 0 otherwise. We generate a placebo treatment variable for each type of macroprudential regulation. The results of this test are shown in Panel C of Table 8. The coefficient on all of our placebo treatment variables remains indistinguishable from zero, providing support for our baseline results.

Table 9
Placebo regressions

Panel A: Capital requirements								
	Non-Bank lending				**Interbank lending**			
Capital requirements*Type $_{(t-1)}$	0.203	0.171			0.064	0.133		
	(1.26)	(1.08)			(0.81)	(1.63)		
Capital requirements*Type $_{(t-2)}$	-0.084		-0.007		0.152		0.149	
	(-0.83)		(-0.05)		(1.05)		(1.00)	
Capital requirements*Type $_{(t-3)}$	0.063			0.032	-0.072			-0.033
	(0.98)			(0.45)	(-0.81)			(-0.26)
Observations	3,822	4,013	3,917	3,822	3,822	4,013	3,917	3,822
R-squared	0.574	0.570	0.572	0.573	0.576	0.573	0.572	0.575
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country
Panel B: Lending standards								
	Non-Bank lending				**Interbank lending**			
Lending standards*Type $_{(t-1)}$	0.071*	0.050			0.034	0.021		
	(2.04)	(0.92)			(0.99)	(0.43)		
Lending standards*Type $_{(t-2)}$	0.056		0.014		0.122		0.060	
	(1.13)		(0.14)		(1.26)		(0.56)	
Lending standards*Type $_{(t-3)}$	0.045			0.063*	-0.191*			-0.176*
	(1.17)			(2.01)	(-2.07)			(-1.90)
Observations	3,822	4,013	3,917	3,822	3,822	4,013	3,917	3,822
R-squared	0.574	0.569	0.572	0.574	0.577	0.572	0.572	0.576
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country
Panel C: Reserve requirements								
	Non-Bank lending				**Interbank lending**			
Reserve requirements*Type $_{(t-1)}$	-0.032	-0.030			0.046	0.050		
	(-0.29)	(-0.30)			(0.32)	(0.40)		
Reserve requirements*Type $_{(t-2)}$	0.025		0.028		-0.083		-0.069	
	(0.29)		(0.36)		(-0.52)		(-0.43)	
Reserve requirements*Type $_{(t-3)}$	0.039			0.041	-0.034			-0.042
	(0.52)			(0.57)	(-0.16)			(-0.19)
Observations	3,822	4,013	3,917	3,822	3,822	4,013	3,917	3,822
R-squared	0.573	0.569	0.572	0.573	0.575	0.572	0.572	0.575
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country

Notes. Table 9 illustrates the results of placebo regressions. We replicate the results from Table 5, replacing the treatment variable in specification 1 with its forwarded values by 1, 2 and 3 quarters. Non-bank lending refers to foreign banks' lending to the UK private non-bank sector and interbank lending to foreign banks' interbank lending in the UK. All variables are winsorized at 5th and 95th percentile. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Our next robustness test reconsiders the parallel trends assumption. We replicate our main results but forward our treatment variable by one, two and three quarters. This test allows us to establish whether the treatment effect we observe in Table 5 is a result of some general trends in lending behaviour of branches and subsidiaries or truly due to changes in macroprudential regulation. The intuition is that if the latter is true, we should not observe significant differences in lending of branches and subsidiaries prior to the real occurrence of the regulatory change. We report the results of these tests in Table 9. In all cases, the forwarded treatment variable shows no statistical significance, which further strengthens the argument that the disparities between the lending provided by foreign banks' branches and subsidiaries are due to changes in the intensity of macroprudential regulation in their home country.

In Table 10 we aim to examine if the effects presented in Table 5 hold if we exclude banks from any country that tightens capital requirements. This exercise addresses concerns that the results presented in Table 5 could be driven by changes in any particular country or a high frequency of changes in capital requirements in India reported in Panel D of Table 1. Our results do not suggest that this is the case. Excluding banks from any given country which tightened capital requirements still yields a statistically significant negative differential effect.

Table 10
Excluding individual countries

Excluded country:	***Ireland***		***South Africa***		***Italy***		***China***	
	Non-Bank lending	Interbank lending	Non-Bank lending	Interbank lending	Non-Bank lending	Interbank lending	Non-Bank lending	Interbank lending
Capital regulation*Type	-0.040	-0.067***	-0.023	-0.055***	-0.023	-0.055***	-0.023	-0.055***
	(-0.43)	(-4.08)	(-0.40)	(-3.21)	(-0.40)	(-3.21)	(-0.39)	(-3.19)
Lending standards*Type	-0.003	0.033	-0.004	0.027	-0.004	0.027	0.013	0.018
	(-0.02)	(0.59)	(-0.03)	(0.55)	(-0.03)	(0.55)	(0.11)	(0.41)
Reserve requirements*Type	0.020	0.031	0.017	0.066	0.017	0.066	0.063	0.068
	(0.18)	(0.29)	(0.17)	(0.62)	(0.17)	(0.62)	(0.66)	(0.53)
Observations	3,879	3,879	4,069	4,069	4,061	4,061	4,025	4,025
R-squared	0.561	0.561	0.561	0.562	0.561	0.563	0.560	0.560
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country
Excluded country:	***Switzerland***		***Australia***		***India***		***Philippines***	
	Non-Bank lending	Interbank lending	Non-Bank lending	Interbank lending	Non-Bank lending	Interbank lending	Non-Bank lending	Interbank lending
Capital regulation*Type	-0.051	-0.056**	0.021	-0.043***	-0.023	-0.055***	-0.023	-0.055***
	(-0.80)	(-2.46)	(0.74)	(-4.75)	(-0.41)	(-3.18)	(-0.41)	(-3.22)
Lending standards*Type	-0.004	0.027	-0.004	0.027	-0.004	0.027	-0.004	0.027
	(-0.03)	(0.53)	(-0.03)	(0.55)	(-0.03)	(0.55)	(-0.03)	(0.55)
Reserve requirements*Type	0.039	0.094	0.017	0.066	0.014	0.076	0.017	0.066
	(0.36)	(0.84)	(0.17)	(0.61)	(0.14)	(0.69)	(0.17)	(0.62)
Observations	3,846	3,846	3,770	3,770	4,028	4,028	4,042	4,042
R-squared	0.574	0.570	0.554	0.566	0.561	0.561	0.559	0.556
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country

Notes. In Table 10 we replicate the results from Table 5 excluding one country affected by the macroprudential regulation tightening at a time. All variables are winsorized at 5th and 95th percentile. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In Table 11, we provide a number of additional sensitivity tests. We replicate the regressions in Table 5 using an alternative control group which includes only subsidiaries of banking groups affected by changes in macroprudential regulation and excludes branches and subsidiaries of banks which are not subject to tighter capital requirements, lending standards or reserve requirements. The results of these tests are reported in Panel A of Table 11 and they remain identical to our baseline results.

Table 11
Additional robustness tests

Panel A: Alternative control group

	Non-bank lending				Interbank lending			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Capital regulation*Type	-0.023	-0.022			-0.057**	-0.059**		
	(-0.38)	(-0.37)			(-2.22)	(-2.44)		
Lending standards*Type	0.000		0.000		0.025		0.026	
	(0.00)		(0.00)		(0.61)		(0.61)	
Reserve requirements*Type	-0.012			-0.012	0.090			0.091
	(-0.12)			(-0.11)	(0.95)			(0.96)
Bank size (ln)	-0.011	-0.011	-0.011	-0.011	0.027	0.027	0.027	0.027
	(-0.49)	(-0.49)	(-0.48)	(-0.50)	(1.13)	(1.13)	(1.13)	(1.13)
Interbank share	-0.223***	-0.222***	-0.222***	-0.223***	0.212	0.208	0.208	0.212
	(-6.05)	(-6.18)	(-6.10)	(-6.09)	(1.65)	(1.63)	(1.64)	(1.65)
Observations	3,576	3,576	3,576	3,576	3,576	3,576	3,576	3,576
R-squared	0.570	0.570	0.570	0.570	0.554	0.554	0.554	0.554
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country

Panel B: Control variables excluded

	Non-bank lending				Interbank lending			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Capital regulation*Type	-0.024	-0.024			-0.057**	-0.059***		
	(-0.42)	(-0.42)			(-2.84)	(-3.13)		
Lending standards*Type	-0.003		-0.003		0.030		0.031	
	(-0.02)		(-0.02)		(0.62)		(0.63)	
Reserve requirements*Type	0.015			0.015	0.059			0.060
	(0.14)			(0.15)	(0.58)			(0.59)
Observations	4,107	4,107	4,107	4,107	4,107	4,107	4,107	4,107
R-squared	0.557	0.557	0.557	0.557	0.562	0.561	0.562	0.562
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country

Panel C: Standard errors clustered at the bank level

	Non-bank lending				Interbank lending			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Capital regulation*Type	-0.059	-0.065			-0.057***	-0.059***		
	(-0.52)	(-0.66)			(-2.27)	(-4.13)		
Lending standards*Type	0.034		0.037		0.020		0.024	
	(0.51)		(0.40)		(0.20)		(0.60)	
Reserve requirements*Type	0.025			0.026	0.084			0.085
	(0.26)			(0.28)	(1.21)			(1.08)
Bank size (ln)	0.001	0.001	0.001	0.001	0.005	0.005	0.005	0.005
	(0.19)	(0.20)	(0.19)	(0.19)	(1.23)	(1.58)	(1.59)	(1.57)
Interbank share	-0.101**	-0.101**	-0.101**	-0.101**	0.039	0.039	0.038	0.039
	(-2.40)	(-2.24)	(-2.19)	(-2.25)	(0.81)	(1.02)	(1.01)	(1.03)
Observations	4,107	4,107	4,107	4,107	4,107	4,107	4,107	4,107
R-squared	0.529	0.529	0.529	0.529	0.515	0.514	0.514	0.514
Bank Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank

Notes. Table 11 presents additional robustness tests of the results presented in Table 5. In Panel A regressions are estimated using an alternative control group, which includes only subsidiaries of banks affected by a tightening of macroprudential regulation. Regressions presented in Panel B replicate results in Table 5 excluding control variables. In Panel C regressions in Table 5 are replicated with standard errors clustered at the bank level. All variables are winsorized at 5th and 95th percentile. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In Panel B, we revisit the validity of the assumption that the changes in macroprudential regulation are exogenous. Whited and Roberts (2012) argue that if the treatment effect is randomly assigned, then the magnitude of this effect should not depend on the inclusion of control variables in the model. Otherwise, random assignment for the treatment variable should be called into question. Additionally, it can be argued that the size of foreign affiliates might affect home-country regulators' decisions regarding the tightening of macroprudential policy. Similar arguments could be made with respect to the level of interbank/non-bank lending provision. Excluding these control variables allows us to test whether any potential endogenous relationship between these variables could bias estimates on our main explanatory variables.

We omit bank-specific time-varying control variables from the baseline specification and find that the magnitudes of the coefficients for the main explanatory variable are very similar to the ones reported in Table 5. Most importantly, the magnitude for the effect of capital requirement changes on interbank lending is almost exactly the same for both models. These results suggest that the treatment effect is exogenous with respect to characteristics of individual branches and subsidiaries, and our main results are not affected by inclusion of potentially endogenous control variables.

Panel C of Table 11 presents results of a robustness test, which examines the sensitivity of our estimates to alternative clustering of the standard errors. Our main results are estimated using a specification in which we cluster heteroskedasticity-adjusted standard errors at the country level. In Panel C, we present the results for tests where errors are clustered at the banking level. Our findings remain very similar. Standard errors are slightly higher compared to those in our baseline model; however, the effect of capital requirements on foreign banks' interbank lending is still significant at 5% level.[26]

4.4 Long-run effects

Our baseline results explore heterogeneity in the effect of regulatory changes on contemporaneous lending provided by foreign banks in the UK. But it is also important to investigate the duration of these effects. To consider this, we modify regression specification 1 in Table 5 by replacing the interaction term with its first, second and third lag. Significant coefficients of the lags of the interactions will inform us about the duration of the effects found in Table 5.

Table 12 presents the results of this analysis. In all of the regressions, the lagged interactions between the *Type* and *Regulation* variables are statistically insignificant. This suggests that the differences in the effect of changes in macroprudential regulation on lending provided by foreign banks' branches and subsidiaries are only contemporaneous and disappear after the quarter in which changes occurred. These results are not surprising; in the case of capital requirements, a tightening requires an immediate response from the banking group. Since the higher degree of control over the branch allows the parent bank to immediately adjust its affiliate branch lending, we

[26] Additionally, we perform tests with standard errors clustered at the banking group level. The results are similar to those in Table 5 and are available upon request.

would expect that the adjustment would be most significant around the announcement of the new capital adequacy regime. In the later quarters, we would not observe the significant differences in lending growth between branches and subsidiaries due to a lack of further adjustments or due to the fact that lending adjustments in case of subsidiary require more time. Once they are in place, the difference between lending growth provided by both types of institutions diminishes.

Table 12
Duration analysis

Panel A: Capital requirements								
	Non-Bank lending				**Interbank lending**			
Capital requirements*Type $_{(t+1)}$	0.159	0.131			-0.030	-0.048		
	(1.13)	(1.17)			(-0.22)	(-0.37)		
Capital requirements*Type $_{(t+2)}$	-0.113		-0.059		-0.102		-0.099	
	(-1.17)		(-1.56)		(-0.50)		(-0.60)	
Capital requirements*Type $_{(t+3)}$	0.109			0.080	0.036			0.017
	(1.20)			(0.73)	(0.22)			(0.12)
Observations	3,911	4,100	4,006	3,911	3,911	4,100	4,006	3,911
R-squared	0.574	0.563	0.571	0.573	0.571	0.571	0.571	0.570
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country
Panel B: Lending standards								
	Non-Bank lending				**Interbank lending**			
Lending standards*Type $_{(t+1)}$	-0.069	-0.049			0.098	0.095*		
	(-1.06)	(-0.74)			(1.66)	(1.85)		
Lending standards*Type $_{(t+2)}$	0.026		0.031		-0.075		-0.065	
	(0.52)		(0.67)		(-0.53)		(-0.47)	
Lending standards*Type $_{(t+3)}$	0.013			0.003	0.016			0.028
	(0.34)			(0.08)	(0.21)			(0.44)
Observations	3,911	4,100	4,006	3,911	3,911	4,100	4,006	3,911
R-squared	0.567	0.557	0.563	0.567	0.562	0.562	0.563	0.561
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country
Panel C: Reserve requirements								
	Non-Bank lending				**Interbank lending**			
Reserve requirements*Type $_{(t+1)}$	0.092	0.082			-0.135	-0.128		
	(1.02)	(0.96)			(-1.16)	(-1.28)		
Reserve requirements*Type $_{(t+2)}$	0.021		0.019		-0.034		-0.037	
	(0.19)		(0.15)		(-0.24)		(-0.28)	
Reserve requirements*Type $_{(t+3)}$	-0.038			-0.034	0.130			0.123
	(-0.49)			(-0.35)	(1.15)			(1.18)
Observations	3,911	4,100	4,006	3,911	3,911	4,100	4,006	3,911
R-squared	0.567	0.557	0.563	0.567	0.562	0.562	0.563	0.562
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country

Notes. Table 12 presents results examining the duration of the effects found in Table 5. We replicate regressions in Table 5, replacing treatment dummies with its three lags. All variables are winsorized at 5th and 95th percentile. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5. Conclusion

Previous studies document that multinational banks transmit negative shocks to their balance sheets – including those triggered by changes in regulation – across national borders. In this paper, we examine if the magnitude of the spillover effects depends on the organizational structure of banks' foreign affiliates. We exploit cross-country

cross-time variation in the implementation of macroprudential regulation to test if lending in the UK by foreign banks' branches and subsidiaries responds differently to a tightening of capital requirements, lending standards or reserve requirements in these foreign banks' home countries.

Our results show that multinational banks' branches respond to tighter capital requirements in their home countries by contracting their lending more than subsidiaries. On average, branch interbank lending growth in the UK grows by 5.7 percentage points slower, relative to subsidiaries following a tightening of capital requirements in the bank's home country. This is in line with our hypothesis which predicts that branch lending will be affected due to the higher degree of control which parent banks have over their foreign branches. But this heterogeneity in response to capital requirements is only observed in the case of lending to other banks. We find that the response of lending to non-bank borrowers to a tightening in capital requirements does not depend on the organizational form of foreign banks' UK affiliates. Turning to the impact of a tightening in lending standards or reserve requirements, we find that there are no differential effects on interbank and non-bank lending.

Our additional analysis reveals that our baseline results are stronger for banking groups which rely more on the collection of soft information for credit decisions, operate more affiliated institutions in the UK, and in which foreign affiliates operate in further geographical distance from their parent banks' headquarter. Parent banks in these banking groups are more likely to delegate more autonomy to boards of their foreign subsidiaries, in which case it is relatively easier to adjust lending of affiliates operating under the branch structure in response to a tightening of capital requirements. We also show that the magnitude of the baseline results is higher for banking groups where the share of the independent board members is higher. This supports our hypothesis that the differential effects are driven by the degree of control which parent banks hold over their foreign institutions operating under different organizational forms.

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Appendix A

The Bank Regulation and Supervision Survey, carried out by the World Bank, is a unique source of comparable world-wide data on how banks are regulated and supervised around the world. The current survey provides information on bank regulation and supervision for 143 jurisdictions. It covers data since 2008, and therefore allows examination of the recent state of bank regulation and supervision in a wide range of countries and comparison with the pre-crisis situation. It is available here:

http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20345037~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html

The current fourth round of the survey started in 2011 and was completed in 2012. For our analysis the most important part of this survey is question 3.6, explaining calculation of minimum capital requirements for banking groups. In Table A we present responses of national regulators which tighten capital requirements and are included in our sample.

3.6 The regulatory minimum capital requirements are applied

a) on a "solo" basis at the individual bank level	The requirements are applied only on the exposures of the individual bank, not taking into account any exposures incurred through its subsidiaries, or, on a pro rata basis, in companies in which the bank holds a minority interest.
b) on a consolidated basis at every banking group or subgroup level	The requirements are applied to subgroups within the conglomerate, taking into account exposures held in subsidiaries, or, on a pro rata basis, in minority interests.
c) on a consolidated basis for the non-bank holding company (if it exists) that is the parent entity of a bank	The requirements are applied to the whole of the group, including the parent holding company of the bank, even when the holding company is not itself holder of a banking license.
d) on a "solo" basis at the holding company level	When it holds a banking license of its own, the holding company itself is subject to capital adequacy requirements, without taking into account exposures of other group companies (including banks).

Table A

Minimum capital requirements calculation: World Bank survey

	AUSTRALIA	*CHINA*	*INDIA*	*IRELAND*	*ITALY*	*PHILIPPINES*	*SOUTH AFRICA*	*SPAIN*	*SWITZERLAND*
3.6 The regulatory minimum capital requirements are applied ….									
a. On a solo basis at the individual bank level	**---**	**X**	**---**	**---**	**---**	**---**	**---**	**---**	**X**
b. On a consolidated basis at every banking group or subgroup level	**X**	**---**	**X**	**X**	**X**	**X**	**---**	**X**	**---**
c. On a consolidated basis for the nonbank holding company (if it exists) that is the parent entity of a bank	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
d. On a solo basis at the holding company level	**---**	**---**	**---**	**---**	**---**	**---**	**X**	**---**	**---**

Appendix B

Table B.1
Macroprudential regulation, banks' cross-border lending and bank size

	Non-bank lending	*Interbank lending*
	(1)	*(2)*
Capital regulation*Type*Bank size	0.001	0.006**
	(0.78)	(2.42)
Lending standards*Type*Bank size	-0.013	-0.024
	(-1.10)	(1.03)
Reserve requirements*Type*Bank size	0.009	-0.001
	(1.71)	(-0.24)
Capital requirements*Type	-0.096	-0.072**
	(-1.73)	(-2.09)
Lending standards*Type	0.028	0.077
	(0.27)	(0.82)
Reserve requirements*Type	-0.074	0.097
	(-0.78)	(0.87)
Bank size (ln)	-0.001	0.032
	(-0.05)	(1.93)
Interbank share	-0.247	0.215
	(-6.44)	(1.93)
Observations	4,107	4,107
R-squared	0.573	0.569
Group*Quarter FE	YES	YES
Bank FE	YES	YES
Cluster	Country	Country

Notes. Table B.1 reports results of regressions which include interaction terms between *Regulation, Type* and Total assets of individual institutions, which is a proxy for their size. All variables are winsorized at 5th and 95th percentile Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B.2
Macroprudential regulation and banks' cross-border lending: Branch vs. Subsidiary effect

	Non-bank lending		Interbank lending	
	Branch	*Subsidiary*	*Branch*	*Subsidiary*
Capital regulation	0.044	0.014	-0.112***	-0.026
	(1.33)	(0.80)	(-4.26)	(-0.17)
Lending standards	0.082*	0.034*	0.019	0.003
	(1.90)	(1.92)	(0.58)	(0.19)
Reserve requirements	0.002	0.036	-0.026	0.059
	(0.04)	(0.75)	(-0.54)	(1.17)
Bank size (ln)	0.003	-0.011	0.037***	0.019
	(0.42)	(-0.95)	(4.03)	(1.24)
Interbank share	-0.203***	-0.329***	0.220***	0.272***
	(-5.23)	(-4.96)	(6.09)	(4.01)
GDP growth	-0.001	-0.001	-0.001	-0.002
	(-0.02)	(-0.01)	(-0.21)	(-0.44)
Household debt (ln)	-0.090	-0.123	-0.307	-0.218
	(-0.67)	(-0.71)	(-1.60)	(-1.06)
Domestic lending (ln)	0.057	-0.058	0.484***	0.169
	(0.63)	(-0.37)	(5.01)	(1.22)
Observations	1,892	2,028	1,892	2,028
R-squared	0.099	0.096	0.079	0.11
Bank FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES
Cluster	Country	Country	Country	Country

Notes. Table B.2 presents results of regressions examining the effect of macroprudential regulatory changes on lending of foreign banks in the UK. We estimate the following model: $\Delta y_{ijkt} = \alpha_i + \beta(Regulation_{kt}) + \varphi BC_{it} + \delta CC_{kt} + \gamma_i + \gamma_t + \varepsilon_{ijkt}$ separately for branches and subsidiaries of multinational banks. Our dependent variables include foreign banks' lending to the UK non-bank sector and foreign banks' interbank lending in the UK. All dependent variables are in percentage point growth rates. The main explanatory variable *Regulation,* a dummy for regulatory change, equal to 1 if regulation is tightened in country *i* at quarter *t*, and 0 for all other periods. The coefficient β provides information about the effect of macroprudential regulation tightening on foreign banks' lending in the UK, irrespective of their organizational form. The set of bank-time varying control variables (BC) include the logarithm of banks' total assets (Bank size (ln)), and the share of interbank lending (Interbank share). Country-time varying control variables (CC) control for countrys' GDP growth, level of household debt, and total domestic lending provided by domestic banks. Additionally, regressions include bank and quarter fixed effects. All variables are winsorized at 5th and 95th percentile. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.